

LAKE MICHIGAN STUDIES

Special Report Number LM8

LAKE TEMPERATURES

April 1963

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control
Great Lakes-Illinois River Basins Project

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QUESTION

1. A company has a current ratio of 1.5 and a debt to capitalization ratio of 0.4. The company's current assets are \$100 million. What is the company's current liabilities?

ANSWER

Current ratio = Current assets / Current liabilities
1.5 = 100 / Current liabilities
Current liabilities = 100 / 1.5 = 66.67 million

Debt to capitalization ratio = Debt / Capitalization
0.4 = Debt / Capitalization
Debt = 0.4 * Capitalization

Current assets = Debt + Equity
100 = Debt + Equity
100 = 0.4 * Capitalization + Equity

Capitalization = Debt + Equity
Capitalization = 0.4 * Capitalization + Equity
0.6 * Capitalization = Equity

Equity = 0.6 * Capitalization
Equity = 0.6 * (Debt + Equity)
Equity = 0.6 * Debt + 0.6 * Equity
0.4 * Equity = 0.6 * Debt
Equity = 1.5 * Debt

Debt = 0.4 * Capitalization
Debt = 0.4 * (Debt + Equity)
Debt = 0.4 * Debt + 0.4 * Equity
0.6 * Debt = 0.4 * Equity
Debt = 0.6667 * Equity

Equity = 1.5 * Debt
Equity = 1.5 * (0.6667 * Equity)
Equity = 1.0 * Equity

Equity = 100 million
Debt = 66.67 million

INTRODUCTION

Purpose

Knowledge of temperatures within the waters of a lake and variations in water temperature, from place to place and from time to time, yields valuable insight into such questions as density stratification, extent and effectiveness of mixing, and consequent variations in water quality.

This paper presents the results of temperature observations in Lake Michigan, a review of and comparison with recorded previous studies, and the conclusions which may be drawn concerning temperature regimes and the fate of pollutants discharged into the Lake.

Period of Study

Field observations of temperature changes in Lake Michigan began in September 1961, and continued on an intermittent basis during the winter, spring, summer, and fall of 1962. Temperature profiles were made throughout the lake at the sampling station sites (Figure 1, and Figure 1 of Special Report Number LM2). Temperature measurements were made in the deeper portions of the lake during the winter of 1961-62.

Definitions

Stratification in a lake means that its waters are divided into layers having identifiable differences in temperature, density, or other characteristics with rather sharply defined boundaries or zones of transition between layers. Thus, a lake in which the temperature was either constant or varied uniformly from top to bottom would not be thermally stratified. A deep lake in the temperate zone usually stratifies, however, especially during the summer period. Very shallow lakes rarely stratify, due to constant mixing from top to bottom by wind action. However, during prolonged calm periods in mid-summer, even shallow lakes will stratify for short periods of time. A typically stratified lake is divided into three layers: the top layer, called the epilimnion; the bottom layer, called the hypolimnion, and a zone of rapid temperature change called the thermocline. The thermocline is normally defined as any abrupt change in temperature which would indicate that there are two vertically separated masses of water. There may also be: secondary thermoclines, where more than one exists; winter thermoclines, where colder but less dense water lies over warmer but denser water; and pseudo or false thermoclines, sometimes produced by unusual local conditions.

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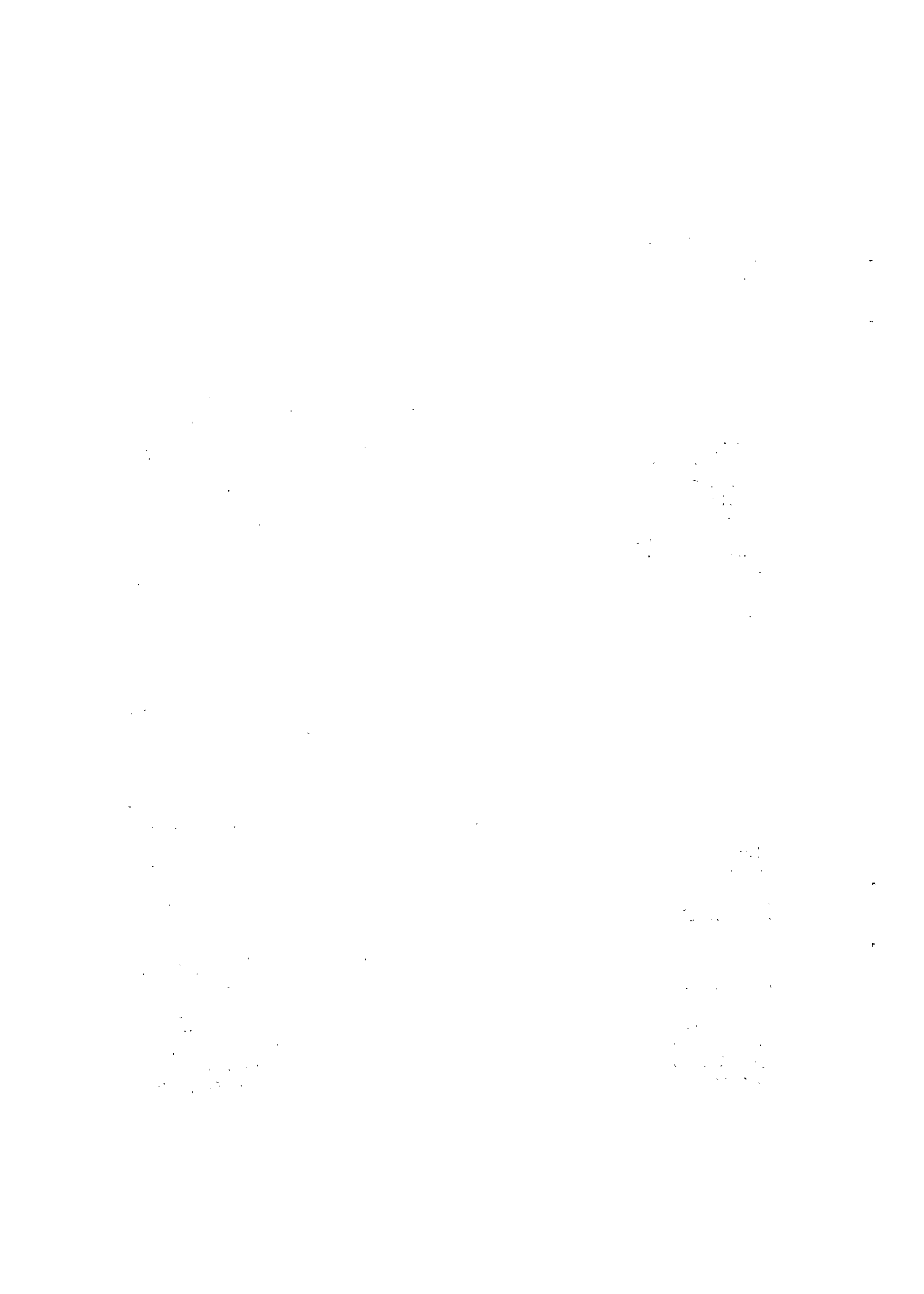
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In Lake Michigan the epilimnion varies from a few feet in thickness in late spring or early summer to over 200 feet in late fall. The thermocline normally ranges about 20 feet thick but can be over 50 feet in thickness or as little as two feet (during storm periods, as shown by studies in other lakes). The hypolimnion encompasses all the water below the thermocline.

An overturn is a descriptive term denoting vertical mixing or circulation from top to bottom of the entire lake. If the lake is shallow a complete overturn may occur. Lakes which are extremely deep or sheltered from the wind may only experience a partial or incomplete overturn. An overturn occurs when the lake is isothermal and therefore of the same density. According to Welch the thermal resistance is at a minimum and relatively light winds could cause complete circulation (1). Most lakes in the temperate zone have an overturn in the spring and fall. In Lake Michigan a fall overturn occurs when the lake begins to cool, and is characterized by the sinking and mixing of cold, dense, water from the surface, displacing the warmer and lighter water below. Cooling continues until the lake reaches the temperature of maximum density and the water mass offers little resistance to mixing from the wind energy transferred to late fall storms. Figure 2 shows the temperature-density curve for fresh water. In some deep lakes, such as Lake Michigan, the bottom portion of the lake remains permanently at the temperature of maximum density. (The temperature of maximum density of water varies with pressure and therefore with depth, being about 4°C at the surface and decreasing about 0.06°C per 100 feet of depth.) In Lake Michigan, it appears that the bottom portion of the northern basin remains at the temperature of maximum density throughout the year. This zone of constant temperature was found to extend from the 600-foot level downward during the period of observations. The level probably varies from year to year depending on the severity of the winter. A spring overturn occurs in Lake Michigan when the surface water temperature rises to 4°C and the denser surface water sinks through the less dense layers below.

Previous Studies

Five important studies on the temperatures of Lake Michigan have been published. In addition, hundreds of observations are being taken every day at water intakes by the plant operators. The bulk of this data normally is not published and not readily accessible for general use. Several thousands of observations have been made over the past 15 to 20 years by research groups or other interested agencies for application to other problems, such as biological studies. The U.S. Navy made observations during World War II in its



submarine tests in Lake Michigan (2). The Great Lakes Research Institute of the University of Michigan and the U.S. Bureau of Commercial Fisheries at Ann Arbor, Michigan have collected and filed several thousand temperature soundings.

The five principal published studies on Lake Michigan are: Van Oosten, Church, Millar and Ayers, et al. (3)(4)(5)(6)(7) Van Oosten carried out most of his work in 1930-32 but the data was not published until 1960 (3). The work by Church in the 1940's is probably the most comprehensive published to date, covering all seasons of the year (4)(5). Millar's studies were for the surface waters of the lake and utilized the temperature recordings from ships' intakes. The study does not include the mid-winter period (6). Ayers et al. presented detailed temperature profiles for various sections of the lake during four synoptic cruises in the summer of 1955 (7). Van Oosten lists several of the minor published studies on temperature in Lake Michigan.

Although many studies of temperature have been made in Lake Michigan there has been a paucity of data for the winter period and specifically from the deeper parts of the lake.

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METHOD OF STUDY

Instruments

The present investigation by the Great Lakes-Illinois River Basins Project utilizes a variety of instruments. The bathythermograph, reversing thermometer, hand thermometers and the temperature recorder are all being used. The bathythermograph (BT) (Figure 3) was invented and first described by Spilhaus in 1937 (8). The instrument was not generally available until the end of World War II, and even then the cost was still prohibitive for its general usage. A description of its operation and capabilities has been published (9). The most accurate of all thermometers is the reversing thermometer, often called a deep-sea thermometer. A detailed description and specifications have been reported by Welch (10). A hand thermometer, of the armored type, is used for calibration of the BT. The temperature recorder, developed at Woods Hole Oceanographic Institution, has been designed for long periods of recording, unattended, and at great depths (11).

In general, the instruments have the following ranges of accuracy:

Table 1
Degree of Accuracy of Instruments

Instrument	Range in °C
Hand Thermometer	± 1.0
Temperature Recorder	± 0.25
Bathythermograph	± 0.1
Reversing Thermometer	± 0.01

The BT is useful in obtaining a complete temperature profile, taking a few minutes of time even in 900 feet of water. The reversing thermometer can get accurate temperatures at one depth (such as a sampling depth) in a period of three or four minutes. A series of these instruments are frequently used on a single line. The temperature recorder can be placed at a specific depth and set to record the temperature every 30 minutes on a strip-chart for periods as long as six months. These recorders are mounted in conjunction with current meters.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and processing, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that the data remains reliable and secure throughout its lifecycle.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It stresses the importance of a data-driven approach in decision-making and the need for continuous monitoring and improvement of the data management process.

Cruises

Since April 1962 the Project has conducted sampling cruises on Lake Michigan. These cruises are listed in Table 2. Prior to April 1962, temperature data was collected from several types of vessels, including those operated by the Project.

Table 2
Schedule of Cruises

Vessel	Dates	Operating Area
PHS	9/27/61	South Basin
PHS	10/6/61	"
USCG-26'	10/11/61	"
USCG-Woodbine	10/21/61	"
USCG-40'	10/24/61	"
USCG-40'	11/3/61	"
USCG-40'	11/8/61	"
USCG-40'	11/15/61	"
USCG-40'	11/21/61	"
USCG-36'	11/29/61	"
USCG-64'	12/21/61	North Basin
USCG-64'	1/25/62	"
USCG-64'	2/20/62	"
USCG-Mesquite	3/1/62	"
R/V Kaho	3/20-22/62	"
R/V Kaho	4/14/62	"
R/V Cisco	4/24-5/7/62	North & South Basins
R/V Kaho	4/26/62	North Basin
R/V Cisco	6/5-18/62	North & South Basins
R/V Kaho	6/20/62	North Basin
R/V Cisco	7/17-30/62	North & South Basins
R/V Cisco	8/29-9/9/62	South Basin
R/V Cisco	10/10-22/62	"
R/V Fitzgerald	10/18-11/30/62	"
R/V Kaho	10/28-11/7/62	"
R/V Kaho	11/28-12/6/62	"

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial statements and for providing a clear audit trail.

2. The second part of the document outlines the various methods used to collect and analyze data. It includes a detailed description of the sampling techniques employed and the statistical tests used to evaluate the results.

3. The third part of the document provides a comprehensive overview of the findings of the study. It discusses the implications of the results and offers recommendations for future research and practice.

4. The final part of the document concludes the study and summarizes the key points. It reiterates the importance of the research and expresses the hope that the findings will be useful to the reader.

RESULTS

Fall, 1961

Studies during the fall of 1961 were made only in the southern basin. This period includes data from the latter part of September through November, based on 75 temperature soundings; a representative number are shown in Table 3, 1 to 12. The inshore areas with depths to 65 feet were nearly isothermal, with surface temperatures of 15.5°C and still 15.0°C at 65 feet. The thermocline appeared sharply defined at depths up to 80 feet and less distinct at depths of 150 feet or more. With the advance of colder weather, the thermocline receded to greater depths and disappeared completely between November 16 and 20. Figure 4 shows the typical changes found in the fall of the year. Temperature soundings were selected to show representative portions of the southern basin.

Winter, 1961-62

The winter period is characterized by surface water temperatures generally below 4°C. During this portion of the year the lake surface may have a partial or a complete ice cover. There have only been a few recorded instances of a complete ice cover, once in the winter of 1935-36, and 1962-63.

The South Basin of Lake Michigan exhibited a different pattern of temperature distribution than the North Basin. The basin separation is a ridge between Milwaukee and Muskegon. In the South Basin, inshore areas out to the 100-foot depth, cooled to temperatures ranging from slightly above 0°C to 1°C, from top to bottom, see Table 3, 12 to 19. The surface layers froze, and in some cases were several feet thick. The inshore cooling occurred rapidly, and the lake was isothermal by mid-January. The central portion of the southern basin cooled at a much slower rate, essentially because of the large volume of water, and was constantly being mixed with the water from the deeper layers.

Studies off Milwaukee in the South Basin in January and February showed a pseudo or false winter-type thermocline. Under normal summer conditions the lake stratifies vertically due to the great density changes. In the winter period the density differences are extremely small. Because the density changes are small near 4°C (temperature of maximum density) some striking thermal variations can occur. The cruise on January 25, 1962 showed the inshore temperatures near 0.2°C whereas the mid-lake

11/11/11

Dear Mr. [Name],

I am writing to you regarding the [Project Name] which is currently in progress. The project is aimed at [Project Description] and is expected to be completed by [Completion Date].

The project is currently in the [Current Stage] stage and is progressing well. We have completed [Completed Tasks] and are currently working on [Remaining Tasks].

We are pleased to have your support and contribution to this project. Your input and feedback are highly valued and will help us to improve the quality of the project.

If you have any questions or concerns, please do not hesitate to contact me at [Contact Information].

Thank you for your support and contribution to this project.

Yours faithfully,
[Signature]

temperatures were almost 2.3°C . The boundary zone between these two water masses was extremely sharp, and the warmer offshore water was found below the colder inshore water. This boundary zone suggests that lateral mixing did not occur very rapidly during this period of the year. The isothermal conditions from top to bottom in the deep part of the South Basin, at temperatures below that of maximum density, would tend to show that vertical mixing occurred throughout this basin.

Studies in the Northern Basin did not show complete mixing from top to bottom as shown for the South Basin. A series of temperature profiles in the deepest portion of the lake disclosed that a winter-type thermocline existed for most of the winter. The maximum depth of the winter thermocline was about the 600 foot level; below this the water temperature was at the temperature of maximum density. The existence of the thermocline approximately at the 600 foot level shows that mixing did not occur below this level. Mixing is known to occur to at least 600 feet. It is likely that the position of the winter thermocline varies from year to year, although the amount of variation is unknown.

The temperatures of the inshore waters and the upper layers of the North Basin were similar to those in the South Basin.

Figure 5 shows some typical winter profiles for the winter of 1961-62.

Spring, 1962

Definite dates marking the beginning or end of spring conditions are difficult to establish, because Lake Michigan is so large. It is possible that the complete spectrum of temperature ranges, from mid-winter to summer conditions, can occur at one time. Such wide variations would most likely occur in spring when the lake is warming, but would not occur in the fall. Figure 6 shows sample temperatures which typify spring conditions in the lake. The cruise of April 24 to May 7 (Table 3, 20 to 35) shows both winter and summer conditions at the same time, in different parts of the lake. The formation of a summer thermocline was observed on April 26 in 55 feet of water with surface temperatures at 6.4°C and bottom temperatures at 4.2°C . Yet, as late as May 1, a winter-type thermocline was found in the North Basin. Spring isothermal conditions still existed in the deeper waters of the North Basin on June 20.

Summer, 1962

Although summer conditions were found in the South Basin in April, the entire lake was not stratified until late July. On July 18 the bottom of the thermocline varied from 25 feet to 70 feet below the surface. Thickness of the thermocline varied from 15 feet on the 18th to 30 feet on the 20th. Secondary thermoclines were found in some portions of the lake at 115 feet on the 19th and they appeared unstable or weak. Typical profiles are shown in Figure 7 and Table 3, 36 to 75. The summer conditions continued through October when the lake had already begun to cool. Variations in thermocline conditions indicate that a great number of combinations of temperature profiles exist simultaneously. A few soundings can only describe the thermal range for a very limited locality.

Oscillations of the Thermocline

Tilting of the thermocline in Lake Michigan has been documented and reported by many observers (12). This phenomenon has also been shown for smaller lakes (13). Wind, blowing across the lake surface can strip off the warm surface layers and pile them on the windward shore of the lake. The stripping exposes the cold deeper layers on the leeward side of the lake and upwelling occurs. In addition to tilting, internal waves on the thermocline will also produce temperature oscillations. The period of internal waves may vary from a few minutes to over 17 hours. The internal waves with a period of 17 hours, are called inertial waves. The term is derived from the fact that the wave travels with an inertial period. Recent studies by C. H. Mortimer indicate that inertial waves on the thermocline can also produce conditions which simulate upwelling, but do not reach the surface (14). These waves, originally generated by wind energy, moved counterclockwise around the basin (according to Mortimer) with a period of 17.5 hours (Lat. 43° north). The wave period is a function of the latitude.

From August 8 through August 15 the Project had three temperature recorders in the lake (Figure 2 of Special Report Number LM7, position shown for May 15). The recorders were at the 30, 50, and 75 foot levels. The records from the 30 ft. and 50 ft. levels showed no significant changes, whereas the recorder at the 75 ft. level showed a pronounced wave on the thermocline. The wave was found for the entire period of record of 150 hours. The period of the wave averaged 17.5 hours and did not vary more than an hour over the 150 hours of observation. Neither the amplitude nor the velocity of the wave is known (see Figure 8). It is known that the wave did not reach the 50 ft. level at this time. The Project data, when compared to studies by Mortimer, show

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the integrity of the financial system and for the ability to detect and prevent fraud. The text notes that without reliable records, it would be difficult to verify the accuracy of financial statements and to identify any irregularities.

2. The second part of the document focuses on the role of internal controls in ensuring the reliability of financial information. It describes how internal controls are designed to prevent errors and misstatements, and to ensure that all transactions are properly authorized and recorded. The text highlights that strong internal controls are a key component of an organization's risk management strategy and are necessary to maintain the trust of investors and other stakeholders.

3. The third part of the document discusses the importance of transparency and disclosure in financial reporting. It explains that providing clear and concise information about an organization's financial performance and position is crucial for making informed investment decisions. The text notes that transparency helps to reduce uncertainty and to build confidence in the financial system.

4. The fourth part of the document addresses the challenges of financial reporting in a complex and rapidly changing environment. It discusses the impact of new technologies, such as artificial intelligence and blockchain, on the way financial data is collected, processed, and reported. The text also notes the increasing pressure on organizations to provide more detailed and timely information to investors and other stakeholders.

5. The fifth part of the document discusses the role of external auditors in providing independent assurance on the accuracy of financial statements. It explains that external auditors are hired to examine an organization's financial records and to provide an opinion on whether the financial statements are presented fairly in all material aspects. The text notes that external audits are a critical part of the financial reporting process and help to ensure the reliability of the information provided to investors and other stakeholders.

6. The sixth part of the document discusses the importance of ethical behavior in financial reporting. It explains that financial reporting is not just a technical exercise, but also a moral one. Organizations have a responsibility to provide accurate and honest information about their financial performance and position, and to avoid any actions that might be considered fraudulent or misleading. The text notes that ethical behavior is essential for maintaining the trust and confidence of investors and other stakeholders.

7. The seventh part of the document discusses the role of government and regulatory bodies in overseeing the financial reporting process. It explains that government agencies, such as the Securities and Exchange Commission (SEC) in the United States, are responsible for enforcing the rules and regulations that govern financial reporting. The text notes that government oversight is essential for ensuring the integrity of the financial system and for protecting the interests of investors and other stakeholders.

8. The eighth part of the document discusses the importance of ongoing education and training for financial reporting professionals. It explains that the field of financial reporting is constantly evolving, and professionals must stay up-to-date on the latest developments and best practices. The text notes that ongoing education and training are essential for ensuring that financial reporting professionals have the skills and knowledge necessary to perform their jobs effectively and ethically.

9. The ninth part of the document discusses the role of technology in improving the efficiency and accuracy of financial reporting. It explains that new technologies, such as artificial intelligence and blockchain, can be used to automate many of the tasks involved in financial reporting, reducing the risk of errors and increasing the speed and accuracy of the process. The text notes that technology is a key driver of innovation in financial reporting and is essential for meeting the growing demands of investors and other stakeholders for more timely and accurate information.

10. The tenth part of the document discusses the importance of collaboration and communication between financial reporting professionals and other stakeholders. It explains that financial reporting is a complex process that involves many different parties, and effective communication is essential for ensuring that everyone is on the same page. The text notes that collaboration and communication are essential for building trust and confidence in the financial reporting process and for ensuring that the information provided is accurate and reliable.

a much purer wave form with little or no distortion. Mortimer's data, taken from water works intakes around the lake, is probably complicated by inshore turbulence and other factors. The direction of rotation during the August 8-15 period is not known. These data shed light on possible temperature fluctuations, frequently found at water works intakes, that do not appear to be related to wind. The inertial oscillation of the thermocline is rhythmic and will usually occur during calm periods. Upwelling (when the cold bottom water comes to the surface) or downwelling will occur when strong winds tilt the thermocline.

Observations in October 1961, from an anchored ship, showed internal waves with periods of several minutes which changed the position of the thermocline as much as seven feet in one hour.

Relationship of Study to Previous Work

Surface temperatures, in general, agreed with the observations of Millar (6). In a few instances the temperature regime of 1961-62 was different. The winter temperatures in the lake for 1961-62 were lower than those reported by Millar, whereas the mid-July temperatures were identical. The winter and spring temperatures of 1962 were generally cooler than the average conditions shown by Millar (6).

The winter temperatures reported by Church in 1941-42 were very similar to the winter of 1961-62 (4)(5). The summer season of 1942 appeared earlier and a thermocline appeared by mid-June. The lagging of the temperature pattern of the North Basin behind that of the South Basin, from spring to summer, was apparent both in Millar's and Church's work.

The results of the four mid-summer synoptic cruises by Ayers et al. are similar to the 1962 summer studies (7).

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial statements and for providing a clear audit trail. The text notes that any discrepancies or errors in the records can lead to significant complications during an audit and may result in the disallowance of certain expenses.

2. The second part of the document addresses the issue of proper documentation. It states that all receipts and invoices must be properly filed and indexed. This not only facilitates the audit process but also helps in the identification and correction of any missing or incomplete records. The document further explains that the lack of proper documentation can be a major red flag for auditors and may lead to the suspension of the organization's funding.

3. The third part of the document focuses on the importance of transparency and accountability. It highlights that all financial activities should be clearly documented and reported to the relevant stakeholders. This includes providing regular updates on the organization's financial status and ensuring that all transactions are properly authorized and recorded. The text stresses that transparency is essential for building trust and for the long-term success of the organization.

4. The fourth part of the document discusses the role of the board of directors in overseeing the organization's financial operations. It notes that the board has a fiduciary duty to ensure that the organization's resources are used in the most effective and efficient manner possible. This involves reviewing the financial statements, approving the budget, and monitoring the organization's financial performance. The document also mentions that the board should establish a strong internal control system to prevent and detect any potential financial misstatements.

5. The fifth part of the document provides a summary of the key points discussed and offers some practical advice for organizations. It encourages organizations to adopt a proactive approach to financial management and to regularly review their financial records and internal controls. The document concludes by stating that maintaining accurate records and proper documentation is not only a legal requirement but also a best practice for any organization that seeks to achieve its mission and sustain its operations.

SIGNIFICANCE OF RESULTS

Temperature soundings taken during the winter of 1961 through the summer of 1962 indicated that the following conditions occur:

1. Temperature profiles show that a seasonal overturn occurs in the southern basin of Lake Michigan, whose maximum depth is about 565 feet.
2. Since the water below 600 feet in the northern basin remains at maximum density throughout the year, no evidence exists at this time to indicate that mixing (due to overturn) occurs below this depth.
3. Inshore vertical cooling and mixing occurs rapidly but the horizontal exchange with the main body of the lake appears to occur at a slower rate. The rate of exchange, vertically or horizontally, is unknown.
4. The northern basin lags thirty days or more behind the southern basin during the late spring and early summer warming period.
5. The southern basin cools at a more rapid rate than the northern basin.
6. Typical temperatures for Lake Michigan for a season or month of the year are difficult to define. The temperature range during one month varies considerably between the two basins at any one time. The temperature range for any given month may be expected to vary widely from year to year depending upon the severity of the winter or the calmness of the summer.
7. Marked changes or configurations of the thermocline from one end of the lake to the other are characteristic of summer conditions in the lake.
8. Inertial waves on the thermocline, usually occurring during calm periods following a strong wind, can produce alternating periods of warm surface water and cold deeper water at a water works intake.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the integrity of the financial system and for the ability to detect and prevent fraud.

2. The second part of the document outlines the specific procedures for recording transactions. It details the steps involved in the accounting cycle, from identifying the transaction to posting it to the general ledger and finally preparing the financial statements.

3. The third part of the document addresses the role of internal controls in ensuring the accuracy of the financial records. It discusses various control mechanisms, such as segregation of duties, authorization requirements, and regular reconciliations, which are designed to minimize the risk of errors and misstatements.

4. The fourth part of the document discusses the importance of transparency and accountability in financial reporting. It highlights the need for clear communication and disclosure of financial information to stakeholders, including investors, creditors, and the public.

5. The fifth part of the document discusses the role of external audits in providing an independent assessment of the financial statements. It explains how audits help to ensure that the financial information is reliable and free from material misstatements.

6. The sixth part of the document discusses the impact of financial reporting on the overall economy. It explains how accurate financial information is essential for investors to make informed decisions and for businesses to attract capital.

7. The seventh part of the document discusses the role of financial reporting in the development of public policy. It explains how financial data is used by government agencies to monitor economic performance and to design policies that promote growth and stability.

8. The eighth part of the document discusses the challenges of financial reporting in a globalized world. It highlights the need for international harmonization of accounting standards and for improved cross-border cooperation to ensure the reliability of financial information.

9. The ninth part of the document discusses the role of technology in financial reporting. It explains how advances in information technology, such as data analytics and artificial intelligence, are transforming the way financial data is collected, processed, and reported.

10. The tenth part of the document discusses the future of financial reporting. It highlights the need for continued innovation and improvement in financial reporting practices to meet the evolving needs of the global economy.

9. Under certain conditions, pollutants discharged into the lake could lie on the thermocline (because of similar densities as explained in Special Report Number LM7) and be brought to the surface during the summer period, by tilting or oscillations of the thermocline.
10. Internal waves with periods of several minutes were observed to change the position of the thermocline as much as seven feet per hour.

The studies clearly indicate the great variability with respect to both location and time, of the water temperatures in Lake Michigan.

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TABLE 3
Representative Temperature Profiles--°C

Depth in Feet	Identification Number								
	1	2	3	4	5	6	7	8	9*
0	15.7	14.7	14.8	12.9	12.8	12.4	11.3	11.2	9.7
25	15.7	14.7	14.4	12.9	12.9	12.4	10.8	11.2	9.7
50		14.6	14.0	12.9	12.9	12.4	10.8	11.2	9.7
75		14.5	10.0	12.9	12.9	12.4	10.8	11.2	9.8
100		11.4	4.5	12.9	12.9	12.0	10.8	10.9	9.8
125		6.5	4.4	12.9	12.4	11.6	10.1	10.6	9.8
150		6.4	4.3	8.7	8.0		9.9	10.0	9.8
175			4.3	5.5	5.6		9.8	9.5	9.8
200			4.3				9.6		
300									
400									
500									
600									
700									
800									
Date	9/27/61	10/6/61	10/11/61	10/21/61	10/21/61	10/24/61	10/24/61	11/3/61	11/8/61
Time	1354	1312	1316	1125	1225	1220	1255	1245	1225
Max. Depth	31	155	210	190	190	141	212	179	192
Bottom Temp.	15.7	6.4	4.3	5.5	5.6	11.6	8.5	9.5	9.8
Basin Location	S	S	S	S	S	S	S	S	S

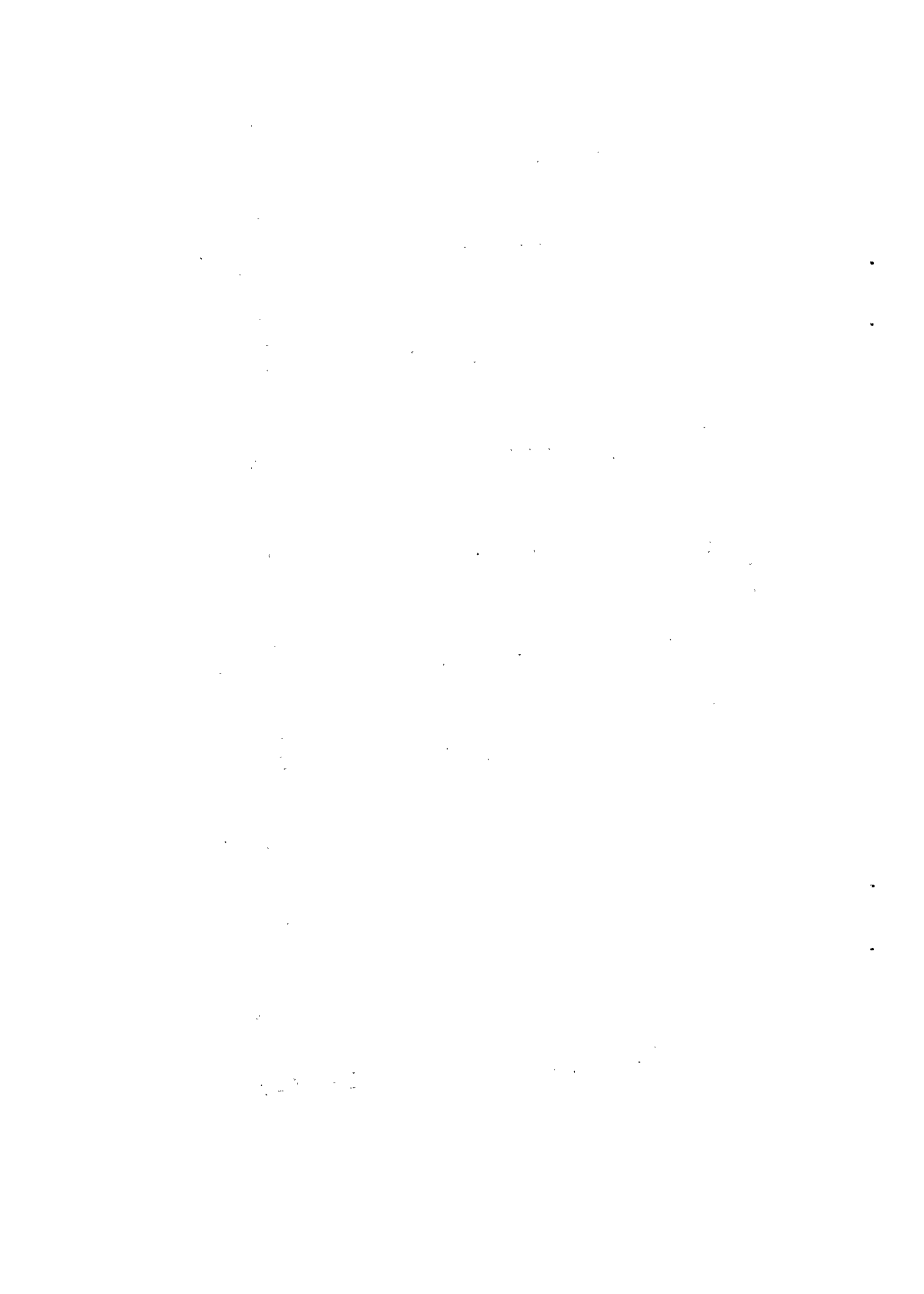


TABLE 3 (Continued)

Representative Temperature Profiles-OC

Identification Number

Depth in Feet	10	11	12	13	14*	15*	16	17	18
0	8.7	7.5	7.4	4.6	3.2	2.6	0.8	0.4	1.8
25	8.7	7.5	7.4	4.6	3.2	2.6	0.9	0.4	1.8
50	8.7	7.5	7.4	4.6	3.1	2.6	0.9	0.4	1.8
75	8.7	7.5	7.4	4.6	3.1	2.6	1.0	0.4	1.8
100	8.7	7.5	7.4	4.6	3.1	2.6	1.2	0.4	1.8
125	8.7	7.5	7.4	4.6	3.1	2.6	1.2	0.4	1.8
150	8.7	7.5	7.4	4.6	3.1	2.5	1.3	0.4	1.8
175	8.7	7.5	7.4	4.6	3.0	2.5	1.4	0.4	1.8
200	7.8	7.5	7.4	4.6	3.0	2.5	1.4	0.4	1.8
300				4.6	3.0	2.5	2.1		3.0
400				4.6	3.0	2.5	3.0		3.2
500					3.0	2.5	3.1		3.4
600					3.0	2.5	3.2		3.5
700					3.0	2.5	3.2		3.6
800							3.3		
Date	11/15/61	11/21/61	11/29/61	12/21/61	1/25/62	2/20/62	3/1/62	3/20/62	3/22/62
Time	1206	1150	1304	1445	1503	1512	1540	2033	1730
Max. Depth	214	220	209	462	500	500	800	-	760
Bottom Temp.	7.6	7.5	7.4	4.6	3.0	2.5	3.3	0.4	3.7
Basin Location	S	S	S	N	S	S	N	N	N

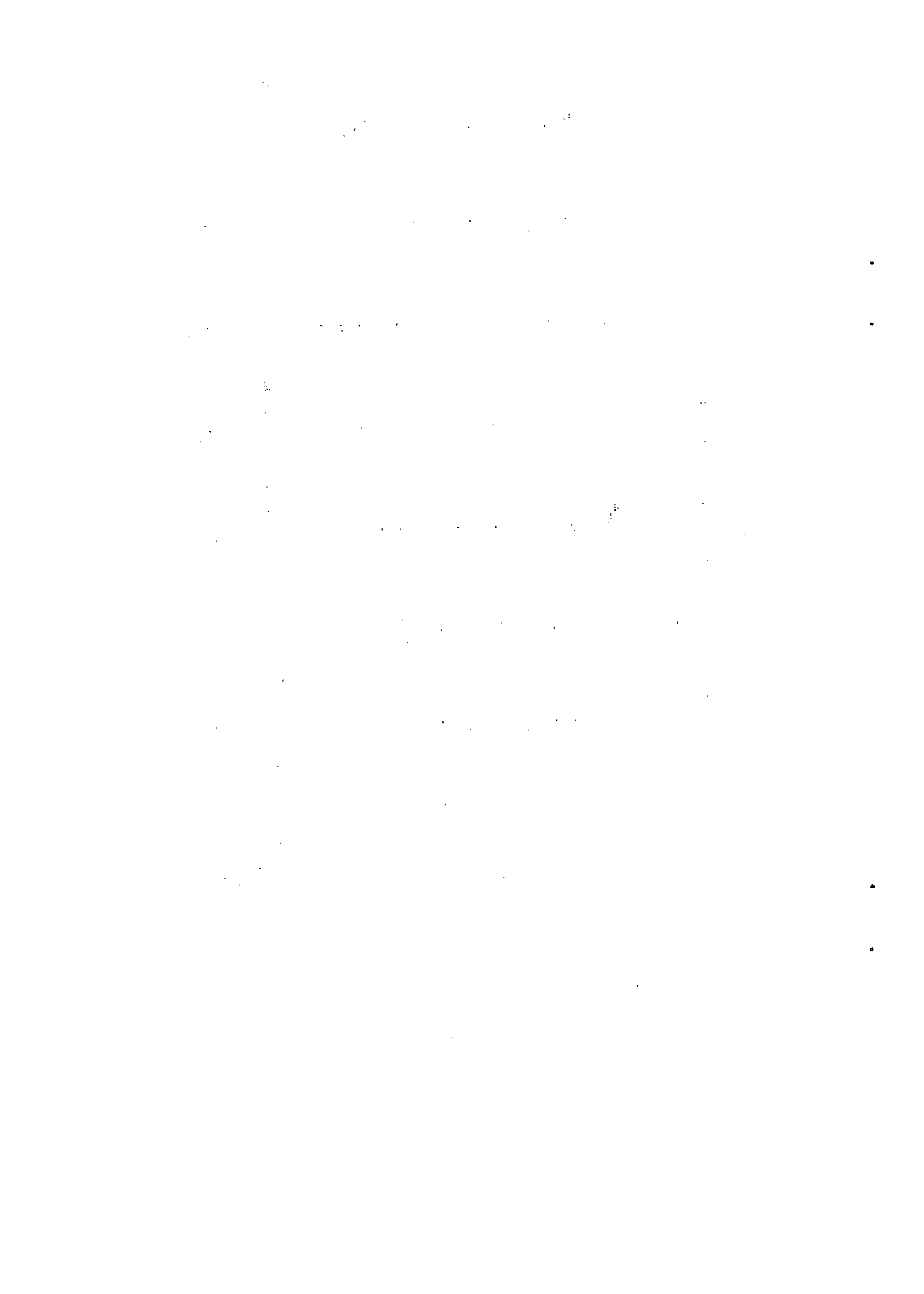
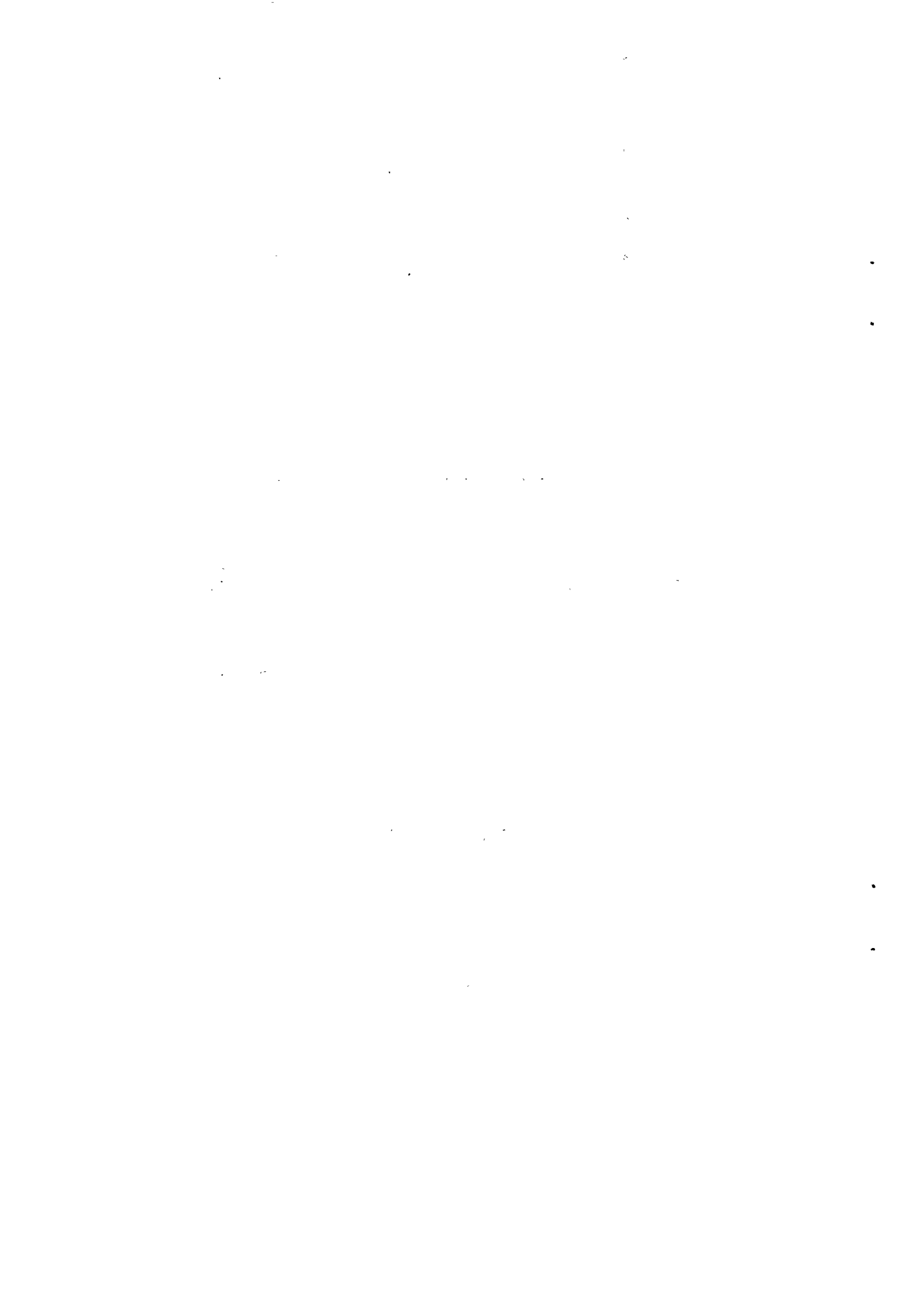


TABLE 3 (Continued)
 Representative Temperature Profiles--°C

Depth in Feet	Identification Number										
	19	20*	21	22*	23*	24	25*	26*	27*		
0											
25	1.8	3.5	6.5	2.4	2.6	6.5	2.3	2.4	2.2		
50	1.8	3.5	6.4	2.4	2.6	4.5	2.3	2.4	2.2		
75	1.9	3.4	6.4	2.4	2.6	4.2	2.3	2.3	2.2		
100	1.9	3.4		2.3	2.5		2.3	2.3	2.2		
125	1.9	3.4		2.3	2.4		2.2	2.3	2.2		
150	1.9	3.3		2.3	2.4		2.2	2.3	2.2		
175	1.9	3.3		2.3	2.4		2.2	2.3	2.2		
200	1.9	3.3		2.3	2.4		2.2	2.3	2.2		
300	1.9			2.3	2.4		2.2	2.3	2.2		
400	2.5			2.4	2.4		2.2	2.2	2.1		
500	3.1			2.4	2.4		2.2	2.2			
600	3.3			2.3	2.5		2.2	2.3			
700	3.4			2.3	3.2		2.2	2.3			
800				2.3	3.4		2.2	2.3			
					3.4		2.2	2.2			
Date	4/14/62	4/24/62	4/25/62	4/25/62	4/26/62	4/26/62	4/26/62	4/26/62	4/27/62	4/28/62	4/29/62
Time	1212	1347	0917	1208	1103	1008	1525	1050	1525	1045	
Max. Depth	750	190	65	-	800	55	355	-	355	-	300
Bottom Temp.	3.5	3.3	6.4	2.3	3.4	4.1	2.1	2.2	2.1	2.2	2.1
Basin Location	N	S	S	S	N	S	S	S	S	S	N



1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent and reliable data collection processes to support informed decision-making.

3. The third part of the document focuses on the role of technology in modern data management. It discusses how advanced software solutions can streamline data collection, storage, and analysis, leading to more efficient and accurate results.

4. The fourth part of the document addresses the challenges associated with data security and privacy. It stresses the importance of implementing robust security measures to protect sensitive information from unauthorized access and breaches.

5. The fifth part of the document explores the impact of data on organizational performance. It shows how data-driven insights can identify areas for improvement, optimize resource allocation, and drive overall business growth.

6. The sixth part of the document discusses the ethical considerations surrounding data collection and use. It emphasizes the need for transparency, informed consent, and responsible data handling practices to build trust with stakeholders.

7. The seventh part of the document provides a summary of the key findings and recommendations. It reiterates the importance of a data-driven approach and offers practical steps for implementing effective data management strategies.

8. The final part of the document concludes with a call to action, encouraging all employees to embrace a data-driven mindset and contribute to the organization's success through their data-related activities.

1. 2000

2. 2001

3. 2002

4. 2003

5. 2004

6. 2005

7. 2006

8. 2007

9. 2008

10. 2009

11. 2010

12. 2011

13. 2012

14. 2013

15. 2014

16. 2015

17. 2016

18. 2017

19. 2018

20. 2019

TABLE 3 (Continued)

Representative Temperature Profiles-°C

Identification Number

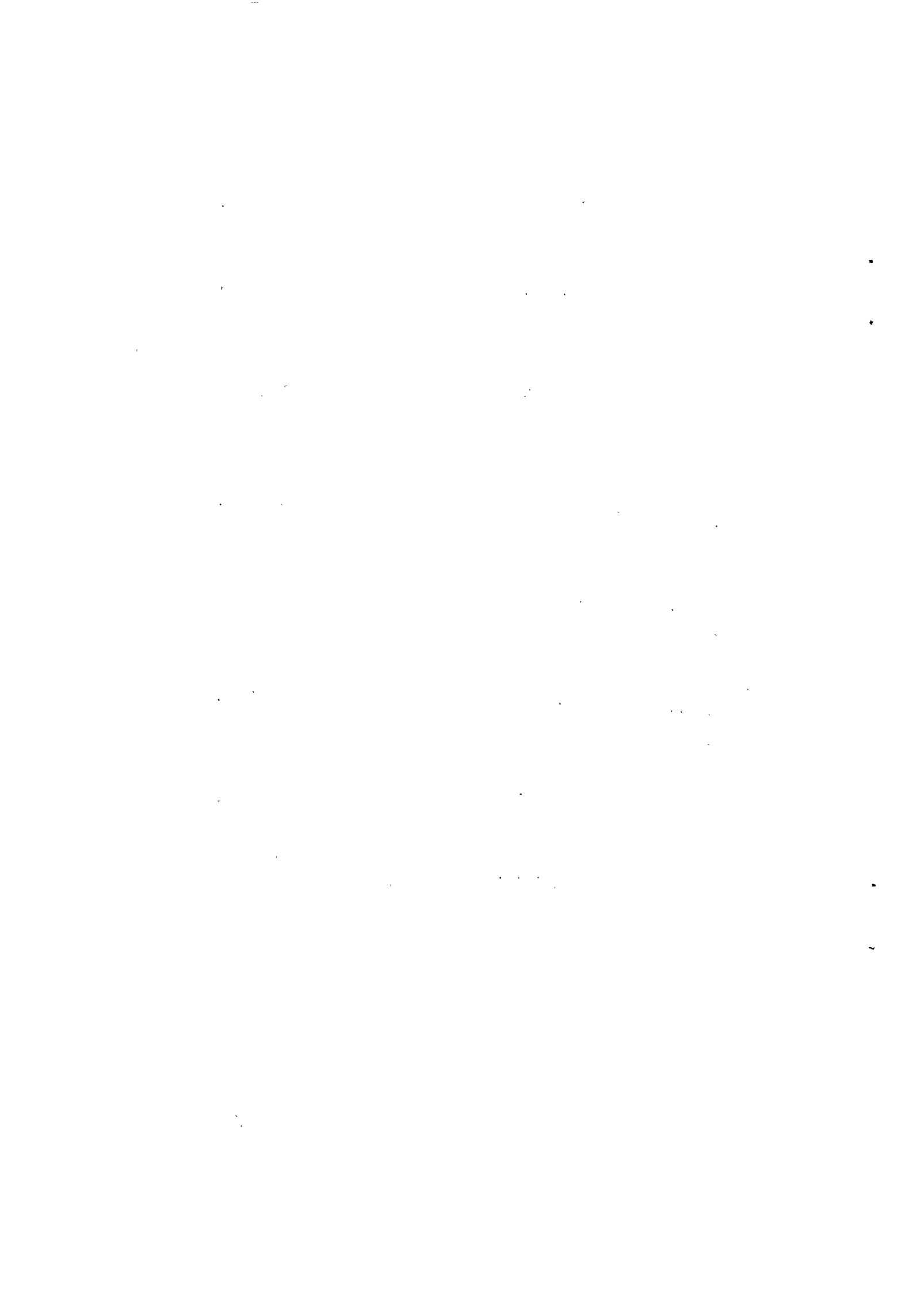
Depth in Feet	46	47	48	49	50	51	52	53	54
0	14.6	18.0	6.6	17.3	17.2	4.2	16.7	20.2	21.4
25	11.2	16.9	5.6	16.9	16.7	4.2	16.0	20.0	21.3
50	10.0		5.3	15.7	15.0	4.2	6.2	8.3	20.4
75	6.5		5.1			4.2		5.0	19.9
100	6.1		4.8			4.2		4.6	
125	6.0					4.1		4.3	
150						4.1		3.9	
175						4.0		3.9	
200						4.0		3.9	
300						3.9			
400						3.9			
500						3.8			
600						3.8			
700						3.8			
800						3.8			
Date	6/14/62	6/15/62	6/16/62	6/17/62	6/18/62	6/20/62	7/17/62	7/18/62	7/18/62
Time	1012	1009	1040	1019	0950	0950	1500	1242	1420
Max. Depth	135	40	115	65	65	830	65	240	70
Bottom Temp.	6.0	16.0	4.6	12.5	12.5	3.8	6.0	3.9	13.6
Basin Location	N	N	N	N	N	N	S	S	S

TABLE 3 (Continued)

Representative Temperature Profiles-°C

Identification Number

Depth in Feet	55	56	57	58	59	60	61	62	63
0	20.5	19.9	17.9	19.0	17.2	17.5	20.8	15.0	15.0
25	19.8	19.7	17.8	18.9	16.9	16.5	20.8	14.9	10.0
50	17.5	10.0	14.4	13.0	12.8	10.1	10.0	14.5	8.7
75	8.2	5.7	8.9		5.6		5.6	4.6	6.6
100	6.7	5.4	6.4		5.0		5.1	4.3	
125	4.5	4.6	5.2		4.9		4.7	4.2	
150	4.5	4.4	4.6		4.7		4.4	4.0	
175		3.9	4.3		4.4		4.3	4.0	
200		3.9	4.2		4.3		4.3	3.9	
300		3.8	3.9		3.8		3.9	3.7	
400		3.8					3.8	3.6	
500								3.6	
600									
700									
800									
Date	7/19/62	7/20/62	7/21/62	7/22/62	7/24/62	7/25/62	7/26/62	7/27/62	7/28/62
Time	1021	1107	0905	0813	1150	1418	0943	1035	0959
Max. Depth	160	-	300	70	300	65	-	510	85
Bottom Temp.	4.5	3.7	3.9	11.0	3.8	8.0	-	3.6	6.5
Basin Location	S	S	S	S	N	N	N	N	N



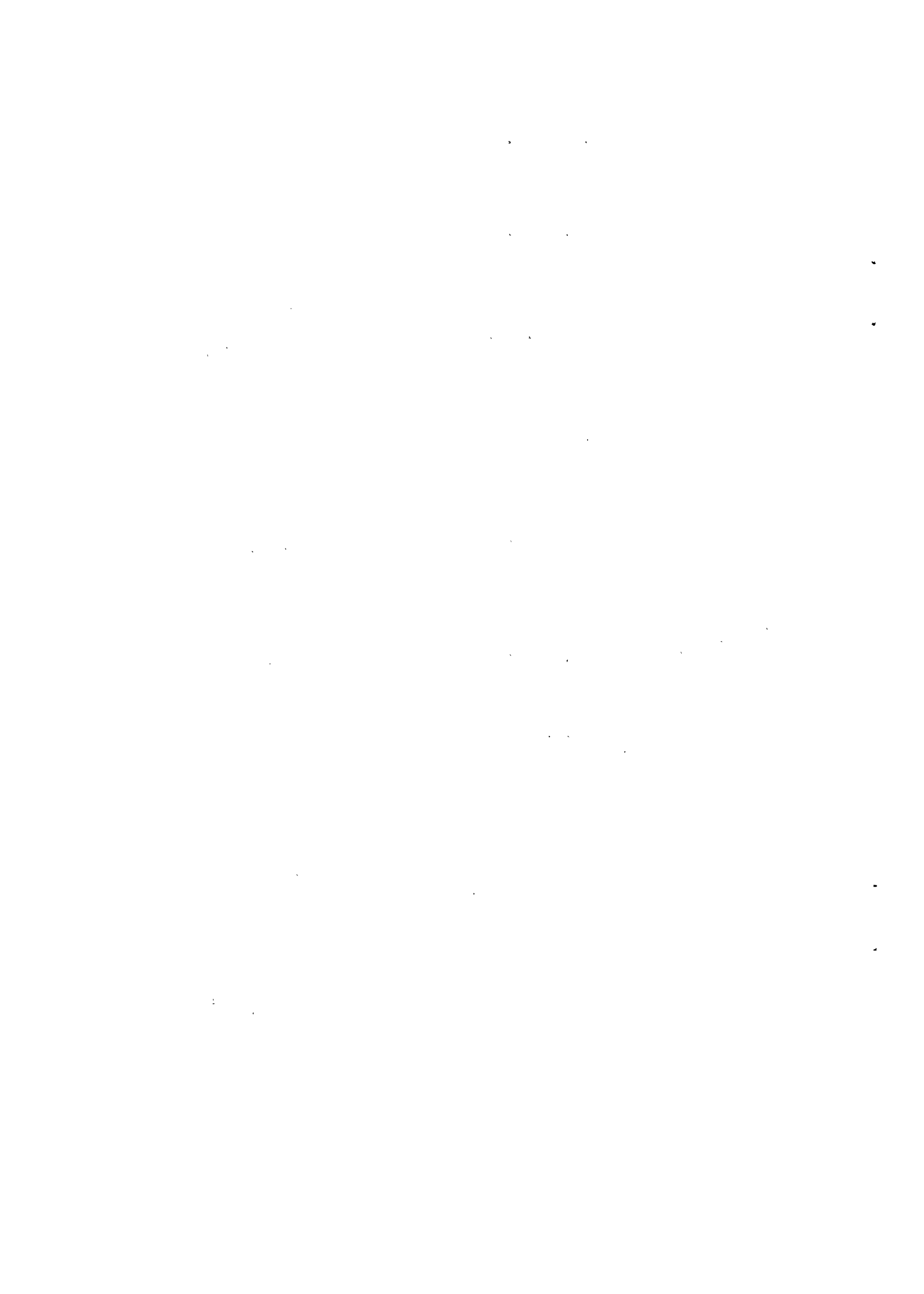


TABLE 3 (Continued)
 Representative Temperature Profiles-°C

Identification Number

Depth in Feet	73	74	75
0	17.0	14.7	16.7
25	16.9	14.7	16.7
50	16.8	14.4	16.7
75	16.8	13.9	16.5
100	16.8	5.4	16.2
125	10.2	4.7	7.7
150	6.5	4.4	5.5
175	6.2	4.4	5.4
200	5.9	4.3	
300		3.9	
400			
500			
600			
700			
800			

Date	10/20/62	10/21/62	10/22/62
Time	1610	1115	1037
Max. Depth	200	320	176
Bottom Temp.	5.9	3.9	5.4
Basin Location	S	S	S

*Denser water lies on top of lighter water
 S: South Basin
 N: North Basin

Handwritten text, likely bleed-through from the reverse side of the page. The text is extremely faint and illegible due to the quality of the scan. It appears to be organized into several lines or paragraphs, but no specific words or numbers can be discerned.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial reporting.

2. The second part of the document outlines the various methods and techniques used to collect and analyze data. It highlights the need for consistent and reliable data sources to support the findings and conclusions of the study.

3. The third part of the document presents the results of the analysis, showing the trends and patterns observed in the data. It includes detailed tables and graphs to illustrate the key findings and provide a clear visual representation of the information.

4. The final part of the document discusses the implications of the findings and offers recommendations for future research and practice. It suggests that the insights gained from this study can be applied to improve decision-making and optimize performance in the relevant field.

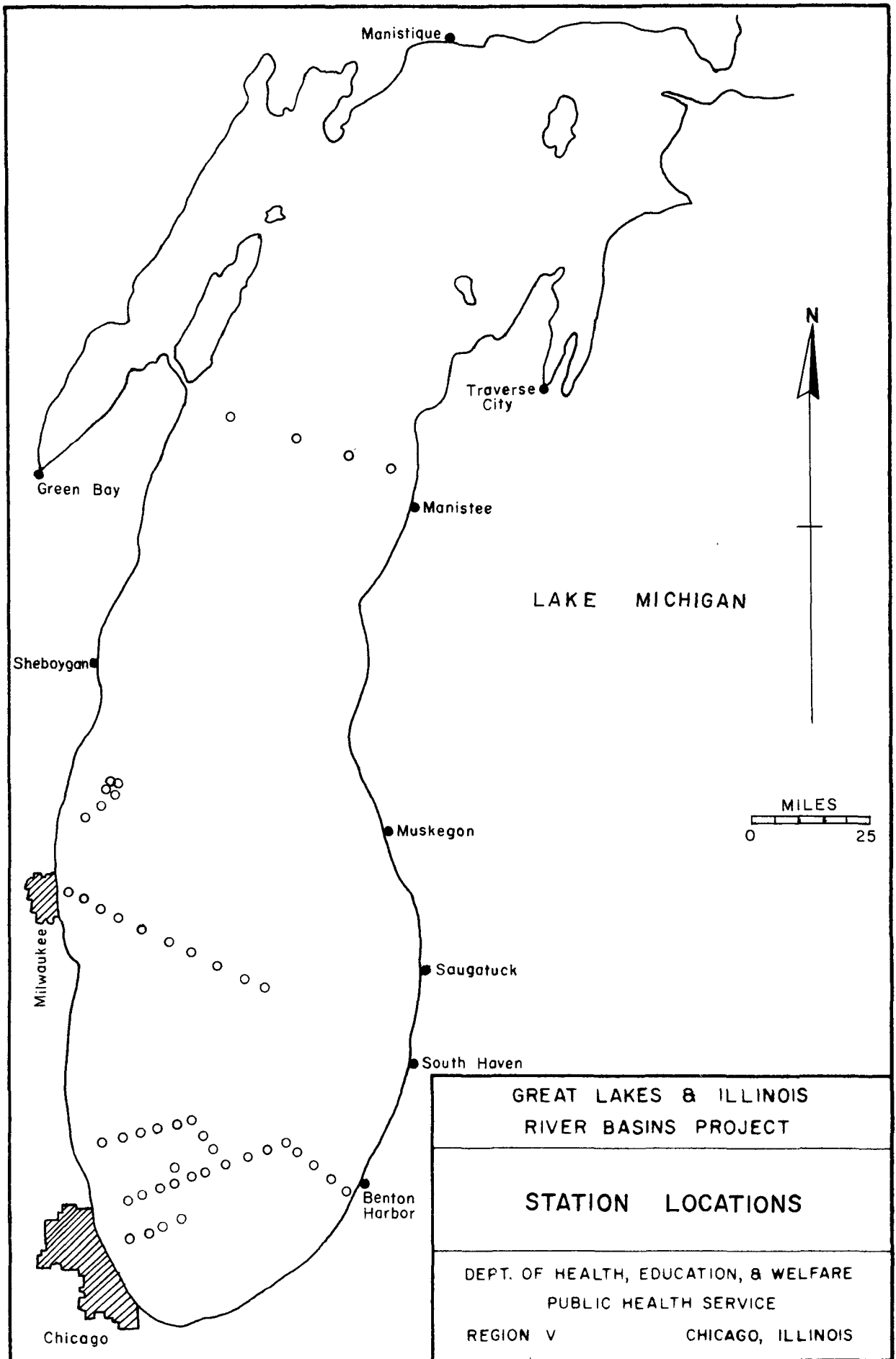
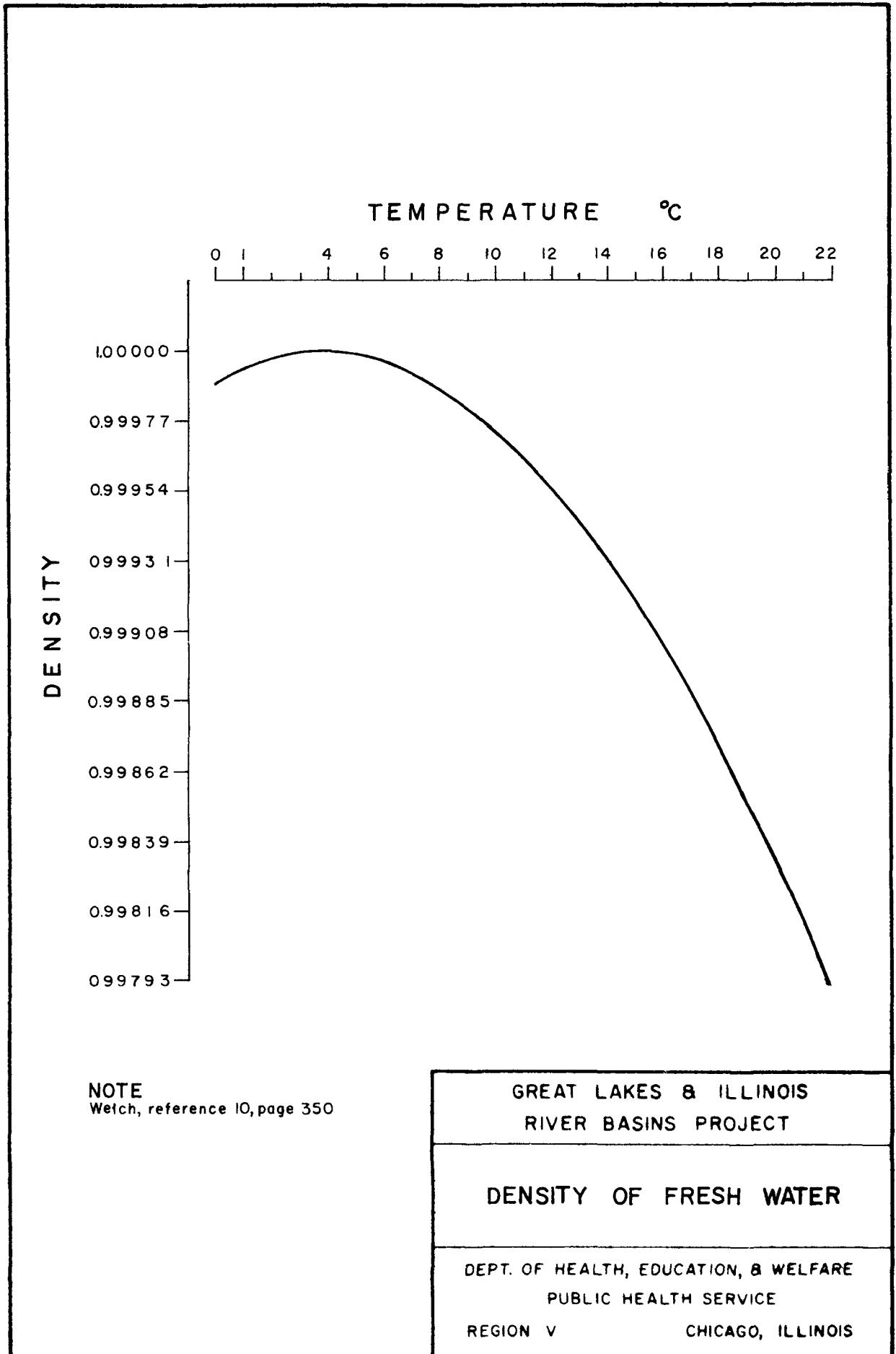


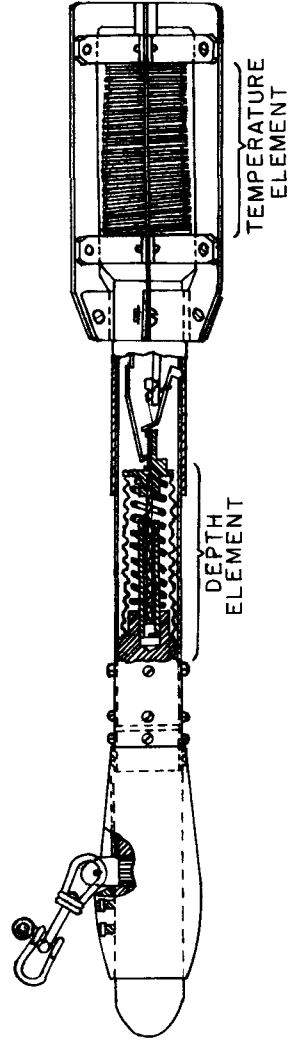
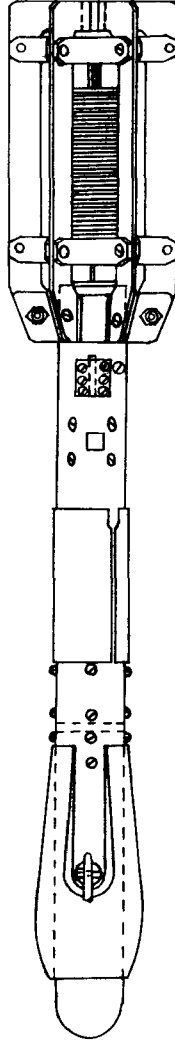
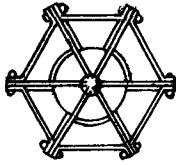
FIGURE 1



NOTE
 Welch, reference 10, page 350

GREAT LAKES & ILLINOIS RIVER BASINS PROJECT	
DENSITY OF FRESH WATER	
DEPT. OF HEALTH, EDUCATION, & WELFARE PUBLIC HEALTH SERVICE	
REGION V	CHICAGO, ILLINOIS

FIGURE 2



GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

THE BATHYTHERMOGRAPH

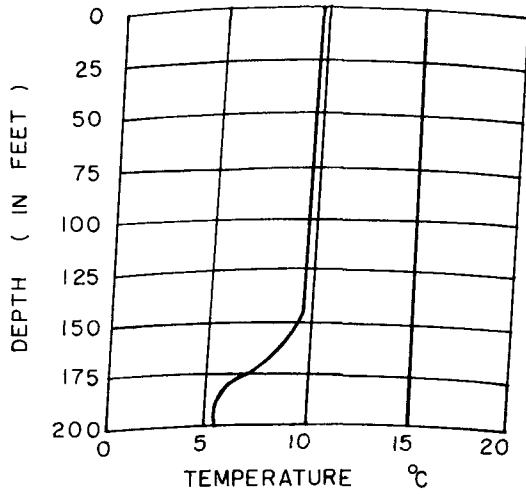
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REGION V

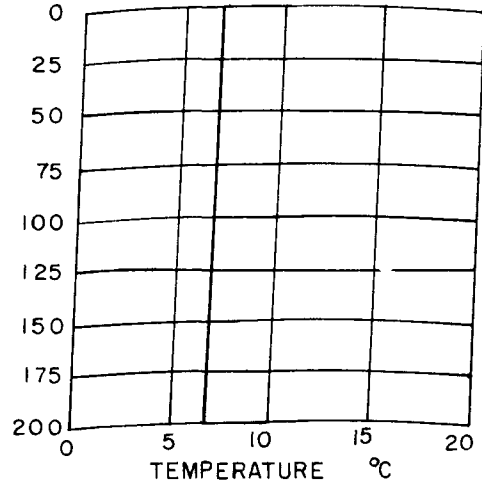
CHICAGO, ILLINOIS

FIGURE 3

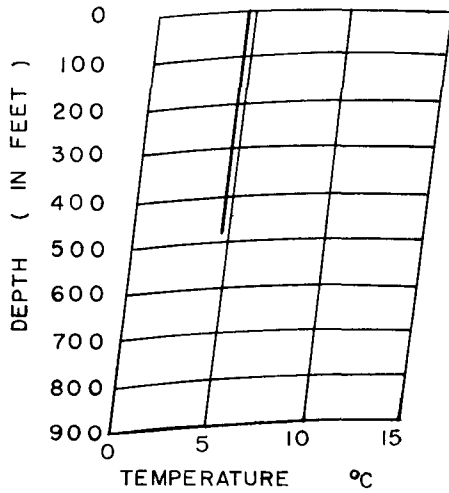




SLIDE NO. 51
 NOV. 15, 1961
 TIME 1319 CST
 BT NO 5834



SLIDE NO. 73
 NOV 29, 1961
 TIME 1229 CST
 BT NO 5834

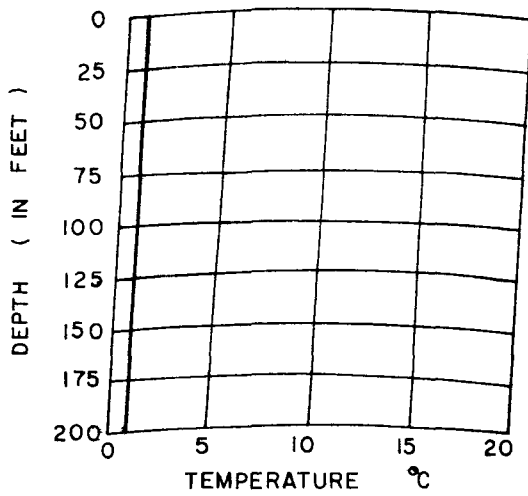


SLIDE NO. 79
 DEC. 21, 1961
 TIME 1345 CST
 BT NO. 48599

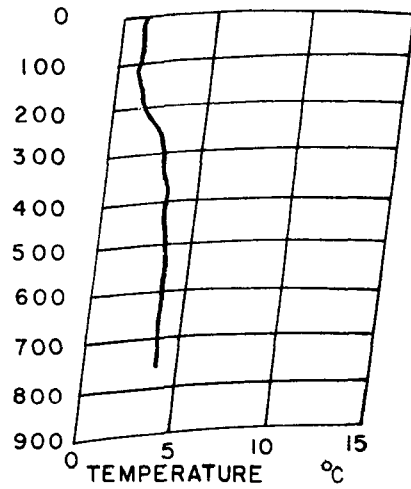
SOUTH BASIN
LAKE MICHIGAN

GREAT LAKES & ILLINOIS RIVER BASINS PROJECT	
TEMPERATURES FALL, 1961	
DEPT. OF HEALTH, EDUCATION, & WELFARE PUBLIC HEALTH SERVICE	
REGION V	CHICAGO, ILLINOIS

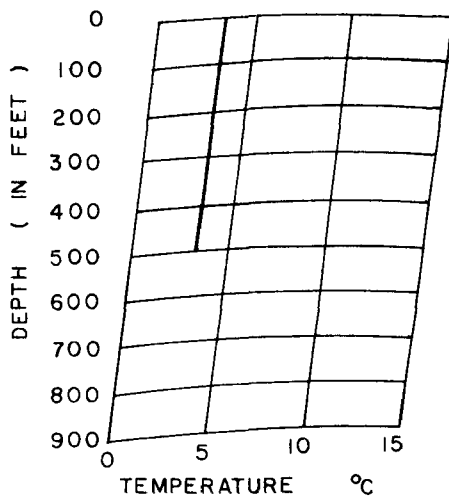
FIGURE 4



SLIDE NO. 1-1
 MARCH 20, 1962
 TIME 1933 CST
 BT NO. 16122



SLIDE NO. 7-1
 MARCH 22, 1962
 TIME 1820 CST
 BT NO. 1241-B

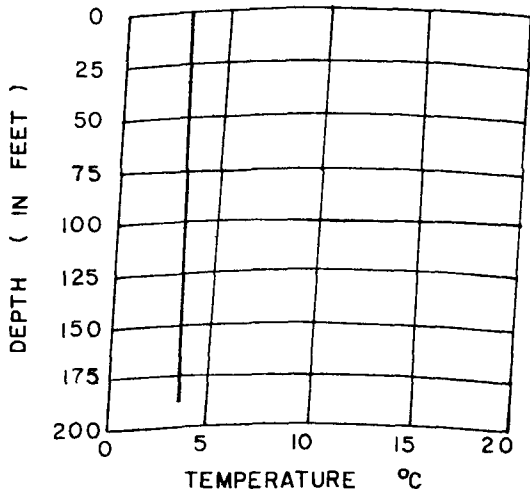


TEMPERATURE °C
 SLIDE NO. 92
 JANUARY 25, 1962
 TIME 1403 CST
 BT NO. 48599

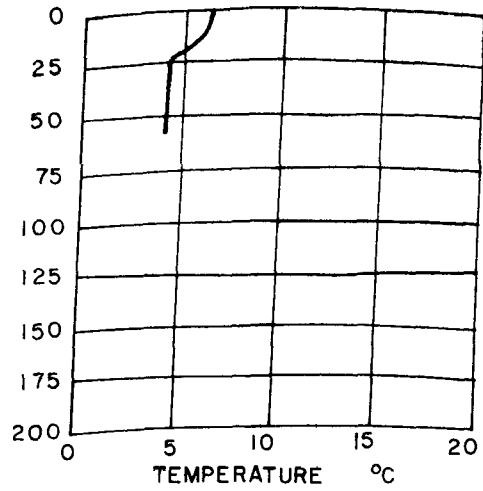
*NORTH & SOUTH
 BASIN
 LAKE MICHIGAN*

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TEMPERATURES WINTER, 1962	
DEPT. OF HEALTH, EDUCATION, & WELFARE PUBLIC HEALTH SERVICE	
REGION V	CHICAGO, ILLINOIS

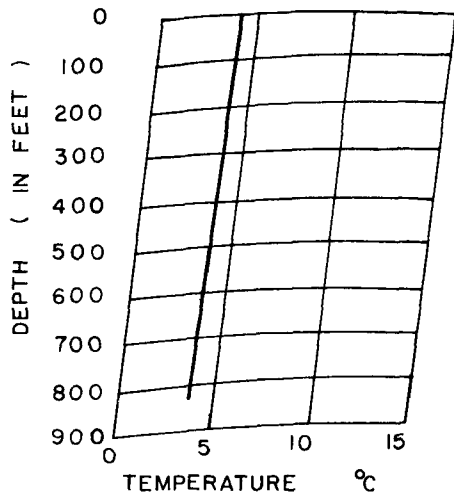
FIGURE 5



SLIDE NO. 2-1
 APRIL 24, 1962
 TIME 1347 CST
 BT NO. 5834



SLIDE NO. 6-1
 APRIL 26, 1962
 TIME 1008 CST
 BT NO. 5834



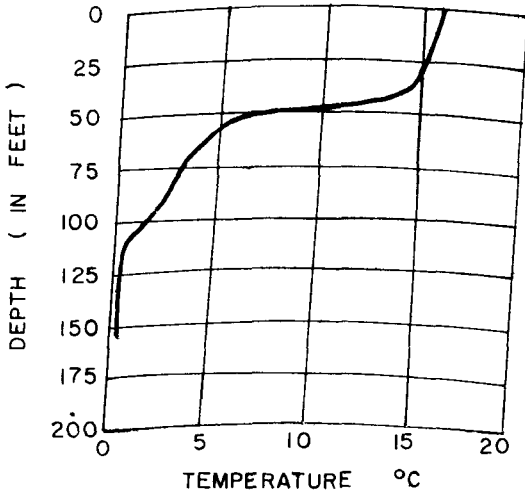
SLIDE NO. 7-3
 JUNE 20, 1962
 TIME 0850 CST
 BT NO. 1241 B

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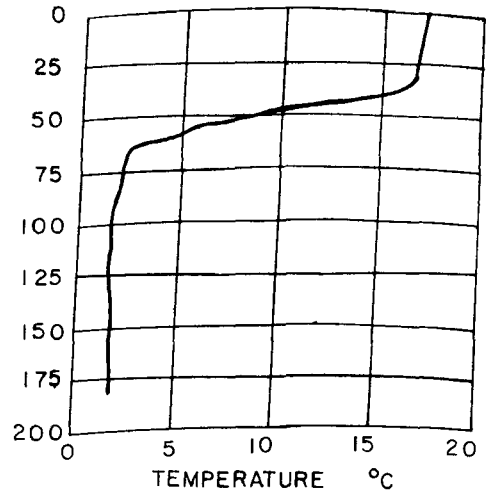
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TEMPERATURES SPRING, 1962	
DEPT. OF HEALTH, EDUCATION, & WELFARE PUBLIC HEALTH SERVICE	
REGION V	CHICAGO, ILLINOIS

FIGURE 6

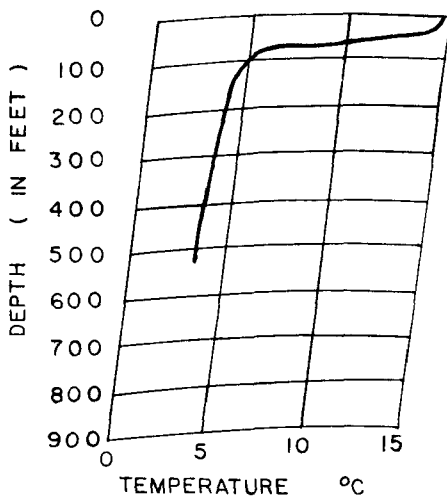




SLIDE NO. 6B-5
 JULY 19, 1962
 TIME 1103 CST
 BT NO. 5834



SLIDE NO. 10A-5
 JULY 20, 1962
 TIME 1427 CST
 BT NO. 5834

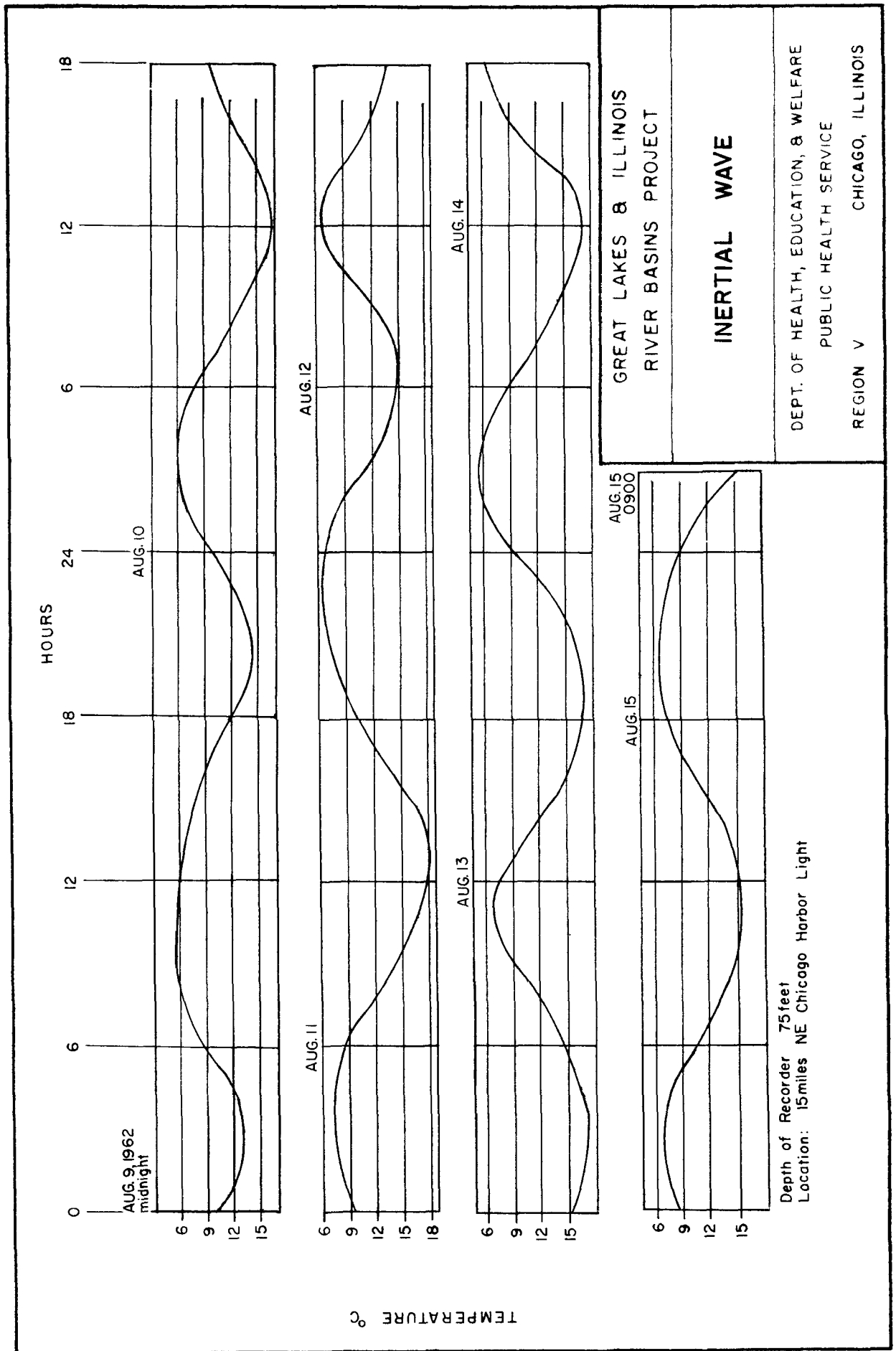


SLIDE NO. 22A-5
 JULY 27, 1962
 TIME 1035 CST
 BT NO. 48599

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TEMPERATURES SUMMER, 1962	
DEPT. OF HEALTH, EDUCATION, & WELFARE PUBLIC HEALTH SERVICE	
REGION V	CHICAGO, ILLINOIS

FIGURE 7



GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

INERTIAL WAVE

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE

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FIGURE 8