Capacity Use Investigation

Report No. 129

Report on the Ground-Water Resources of Horry and Georgetown Counties, South Carolina

State of South Carolina
Water Resources Commission

December 1977

STATE OF SOUTH CAROLINA

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REPORT ON THE GROUND-WATER RESOURCES OF HORRY AND GEORGETOWN COUNTIES, SOUTH CAROLINA

A Ground-Water Capacity-Use Investigation

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SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

In accordance with section 4(c)(2) of the South Carolina Ground Water Use Act (Section 49-5-40(c)(2), 1976 South Carolina Code of Laws) the Executive Director of the South Carolina Water Resources Commission has reviewed the technical data obtained during the Grand Strand Capacity Use Investigation and submits the following conclusions and recommendations for consideration by the Commission.

1. The technical data indicate that the use of ground water has developed to a degree which requires coordination and regulation. The data also indicate that the use of ground water is developing to a degree that the replenishment of ground water is threatened. Therefore, it is recommended that Horry and Georgetown Counties and a section of Marion County be declared a capacity-use area under the provisions of the Act.

2. The following water-use problems of the area involving ground water have been identified and are summarized in this report.

a. Ground-water withdrawals have caused both a regional water-level decline and the local overdevelopment of the Black Creek aquifer system. These water-level declines have caused problems for residents in the study area. Many examples of the lowering of water levels below pump intakes have been documented and, locally, lowered water levels have necessitated the lowering of pumps, the deepening of wells, or the construction of new wells. Evidence indicates that ground-water pumpage is continually increasing and similar problems are likely to occur in

other areas. Provisions related to well depth, spacing and design, proper testing of aquifers during test drilling, and ground-water pumpage are needed to help solve or, at least, alleviate these problems (Section 49-5-50(a)(2) and (3)).

Ground-water pumpage in a quarry dewatering operation has caused problems for local residents in southwestern Georgetown County. Such dewatering constitutes a ground-water use and should be subject to regulatory provisions under the Act. Provisions to protect against adverse affects to water users from such operations should be established.

b. The potential for saltwater encroachment and intrusion has been documented and provisions to limit ground-water pumpage near areas of movement should be established. Continual investigation and monitoring are critically needed in the study area to determine what pumpage limitations would be necessary.

c. A number of problems related to well design and construction have caused adverse effects on water users and aquifers. Saltwater contamination of freshwater aquifers by improperly constructed and abandoned wells are two such problems. Well construction and abandonment standards should be established to prevent the contamination of freshwater aquifers and to protect against the physical hazards of improperly abandoned wells.

d. The most troublesome chemical constituent is fluoride in ground water from the Black Creek aquifer system. In addition to defluoridation, other solutions to this problem are utilization of low fluoride ground water from shallower aquifers or mixing ground water from the Black Creek aquifer and shallower aquifers. Additional research and testing of the shallow aquifers is recommended in order to locate sources of good quality, low fluoride ground water.

Excessive concentrations of chloride and dissolved solids in ground water from the Black Creek aquifer system are troublesome problems in parts of the study area. Well location and design standards should be established to prevent this problem in areas where it is possible to avoid these excessive chemical constituents. The use of alternative aquifers or mixing ground water from shallower aquifers with ground water from the Black Creek aquifer system should be encouraged in the northeastern Grand Strand where all Black Creek aquifers contain salty water. Provisions concerning the proper testing of aquifers are needed to prohibit the development of poor quality water.

e. The lack of requirements for maintaining and submitting well and water use information to a State agency has led to a serious lack of background data on the ground-water resources. Proper procedures for reporting of well and water-use data should be instituted as required under Section 49-5-50(a)(1). The procedures will aid water users in designing wells and will provide important ground-water data which will be used to evaluate and monitor ground-water conditions.

3. As required by the Act, an assessment of existing methods to solve or minimize water-use problems short of implementing capacity-use restrictions has been made. There appears no local, State, or federal law, presently implemented, which is capable of providing appropriate remedies for all of the ground-water use and management problems addressed in this report. While certain voluntary and public information programs would assist in the implementation of a ground-water management program, especially with attention to providing detailed technical information to local officials, engineers, water well drillers and individuals, many problems are sufficiently serious and/or regional in nature to require regulatory action.

The Department of Health and Environmental Control administers statutes and regulations affecting ground water for pollution control and public drinking water systems. Where appropriate and agreeable to the agencies, regulations of mutual concern should be incorporated into existing permit provisions. In the administration of permit requirements, consideration of joint application, issuance or enforcement procedures should be made, where appropriate.

Under certain circumstances, local agencies, the Land Resources Conservation Commission and the Coastal Council in administering their statutory responsibilities, would be interested in, if not benefited by, the implementation of a ground-water management program. Continued and close coordination between the Water Resources Commission and the State agencies, as well as local governmental and planning agencies, should be considered an important aspect of a capacity-use declaration.

4. It is recommended that the capacity use area include the following:

> All of the counties of Horry and Georgetown, such boundaries more particularly described in Section 4-3-310 and 4-3-270 (1976 South Carolina Code of Laws), to the three mile territorial limit on the Atlantic Ocean, and that portion of Marion County known as Britton's Neck, the boundary of such area commencing at the intersection of the Pee Dee River and the Georgetown-Marion-Williamsburg line, thence north approximately eight river miles along the Pee Dee River to a point known as Dunham Bluff, thence north 1.5 miles along the Dunham Bluff road to its intersection with S. C. Road 908, thence north 2.2 miles along S. C. Road 908 to its intersection with S. C. Road 490, thence east 1.6 miles on S. C. Road

480 to its intersection with S. C. Road 86, thence east 0.4 miles along S. C. Road 86 to its intersection with an unnamed road leading to the Little Pee Dee River, thence northeast along such road to the Little Pee Dee River; such boundaries shown on the map entitled "Map Showing Recommended Boundaries of the Capacity Use Area."

5. It is recommended that a permanent field office be continued at Conway. Personnel assigned to this office will be responsible for continuing research on saltwater encroachment and other ground-water problems, data collection, information transfer, and ground-water management. In addition to providing ground-water data to water users in Horry and Georgetown Counties, the data collection and analysis responsibilities of this office should be expanded to include Williamsburg and Marion Counties and southern Florence County.

INTRODUCTION

The Ground Water Use Act of 1969

The South Carolina Ground Water Use Act of 1969 (Sections 49-5-10, et. seq., 1976 South Carolina Code of Laws) provides for the establishment of capacity-use areas where necessary to protect the interests and rights of property owners, and the public in ground-water resources. A capacity-use area, as defined in Section 49-5-40(b), is an area where the South Carolina Water Resources Commission has found that the aggregate use of ground water in or affecting that area (1) have developed or threatened to develop to a degree which requires coordination and regulation or (2) exceed or threaten to exceed or otherwise threaten or impair, the renewal or replenishment of waters or any part of them.

Prior to the establishment of a capacity-use area, the Act requires that the Commission, at the request of a county, municipality or other subdivision of State government, conduct an investigation to determine the need and extent of regulation. The Executive Director must then report the results of this investigation to the Water Resources Commission for their consideration. Requests to conduct the Grand Strand Capacity Use Investigation were made in 1972 by the Horry County legislative delegation and the Georgetown County Board of Commissioners (appendix). The Grand Strand Capacity Use Investigation was initiated in 1973 with the United States Geological Survey, Water Resources Divison, participating in a cooperative funding arrangement. Additional funds for the investigation were provided by the Coastal Plains Regional Commission and local governments.

Section 49-5-50(a) of the Act contains regulatory provisions which must be considered by the Commission concerning the use of ground water in a capacity-use area:

1. Provisions requiring water users within the area to submit reports not more frequently than at thirty-day intervals concerning quantity of water used or withdrawn, sources of water and the nature of the use thereof.

2. With respect to ground waters: Provisions concerning the timing of withdrawals; provisions to protect against or abate salt water encroachment; provisions to protect against or abate unreasonable adverse effects on other water users within the area, including but not limited to adverse effects on public use.

3. With respect to ground waters: Provisions concerning well depth and spacing controls; and provisions establishing a range of prescribed pumping levels (elevations below which water may not be pumped) or maximum pumping rates, or both, in wells or for the aquifer or for any part thereof based on the capacities and characteristics of the aquifer.

4. Such other provisions not inconsistent with this act as the Commission finds necessary to implement the purposes of this act.

In a capacity-use area, a permit for ground-water withdrawals in excess of 100,000 gpd (gallons per day) is required. Section 49-5-60(h) specifies that the Commission consider the following factors in processing permit applications, revocations or modifications under Section 49-5-50:

1. The number of persons using an aquifer and the object, extent and necessity of their respective withdrawals or uses;

2. The nature and size of the aquifer;

3. The physical and chemical nature of any impairment of the aquifer, adversely affecting its availability or fitness for other water users (including public use);

4. The probable severity and duration of such impairment under foreseeable conditions;

5. The injury to public health, safety or welfare which result if such impairment were not prevented or abated;

6. The kinds of businesses or activities to which the various uses are related;

7. The importance and necessity of the uses claimed by permit applicants (under this section), or of the water uses of the area (under Section 49-5-50) and the extent of any injury or detriment caused or expected to be caused to other water uses (including public use);

8. Diversion from or reduction of flows in other water courses or aquifers; and

9. Any other relevant factors.

Sufficient information on these nine factors is required before declaration of a capacity-use area and the establishment of reasonable regulations. These factors have been considered in conducting the Grand Strand Capcity Use Investigation. The Act is comprehensive in that it requires the evaluation of both the quality and quantity of ground-water resources.

Purpose and Scope

This report is submitted as required by Section 49-5-40(c)(2) and contains the Executive Director's findings and recommendations on the Grand Strand Capacity Use Investigation. This section specifies that the report of the Executive Director shall: (1) include the Executive Director's findings and recommendations as to the water use problems of the area involving ground water; (2) specify whether effective measures can be employed limited to ground water, and whether timely action by any agency or person may preclude the need for additional regulation at that time; and (3) include such other findings and recommendations as may be deemed appropriate, including recommended boundaries for any capacity-use area that may be proposed.

Much of the technical data and findings on which this summary report is based is included in the report, "The Occurrence, Availability, and

Chemical Quality of Ground Water, Grand Strand Area and Surrounding Parts of Horry and Georgetown Counties, South Carolina," authored by Mr. Allen Zack, Hydrologist, United States Geological Survey. Mr. Zack's report, submitted to the Commission on July 19, 1977, will be published as a technical ground-water report by the Commission. Pre-publication drafts of the report are on open file and are available for inspection at the following locations:

1. Offices of the South Carolina Water Resources Commission, 3830 Forest Drive, Columbia, South Carolina,
2. Conway Field Office of the South Carolina Water Resources Commission, 221 Main Street, Conway, South Carolina,
3. Georgetown County Library, Georgetown, South Carolina,
4. Horry County Library, Conway, South Carolina, and
5. Myrtle Beach City Hall, Myrtle Beach, South Carolina.

Acknowledgments

Mr. John Stallings, District Chief of the United States Geological Survey, Water Resources Division, Columbia, South Carolina, and his staff were instrumental in this investigation. Special appreciation is extended to Mr. Allen Zack, Hydrologist, United States Geological Survey, Water Resources Division, who served as principal investigator for the project.

Much credit is due the following geologic technicians of the Commission who collected much of the data during the capacity-use investigation and offered many valuable suggestions: Larry West, Ivan Roberts and Dennie Lewis.

Appreciation is extended to the following individuals who reviewed early drafts of the report and offered many constructive criticisms: Marilyn Moore, Dr. Harold Albert, Chris Brooks and Camille Ransom of the

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The assistance of Marilyn Moore and Joe Dennis in the preparation of illustrations is greatly appreciated.

Funding assistance provided by the Coastal Plains Regional Commission and local governments is gratefully acknowledged. The staff of the Commission greatly appreciates the assistance provided by many well-drilling contractors, local officials, consulting engineers and individuals in this investigation.

SUMMARY OF GROUND-WATER RESOURCES

The report on the ground-water resources of Horry and Georgetown Counties by Zack (1977) contains a detailed analysis of the occurrence, availability, and chemical quality of ground water in the study area. Therefore, only a brief summary of the ground-water resources is presented here.

Aquifer Systems

Ground water in the study area occurs under water table and artesian conditions in a series of aquifers (water-bearing sediments) composed essentially of sand and, in some cases, shell beds. The aquifers have been divided into a series of aquifer systems which have similar water-bearing and/or water-quality characteristics. These are, from oldest to youngest: (1) Middendorf (Tuscaloosa), (2) Black Creek, (3) Peedee, (4) Tertiary and (5) Shallow aquifer systems.

The Middendorf aquifer system contains freshwater in a large part of the Pee Dee River Basin but is believed to contain only salty water in most of the study area. No wells, at present, withdraw ground water from the Middendorf aquifer system in Horry and Georgetown Counties.

The Black Creek aquifer system is the principle source of ground water for public and industrial use in the study area. Large capacity wells completed in freshwater sands of the Black Creek aquifer system range in depth from less than 400 feet in the northern Grand Strand to approximately 900 feet in the Waccamaw Neck area. Most of the large

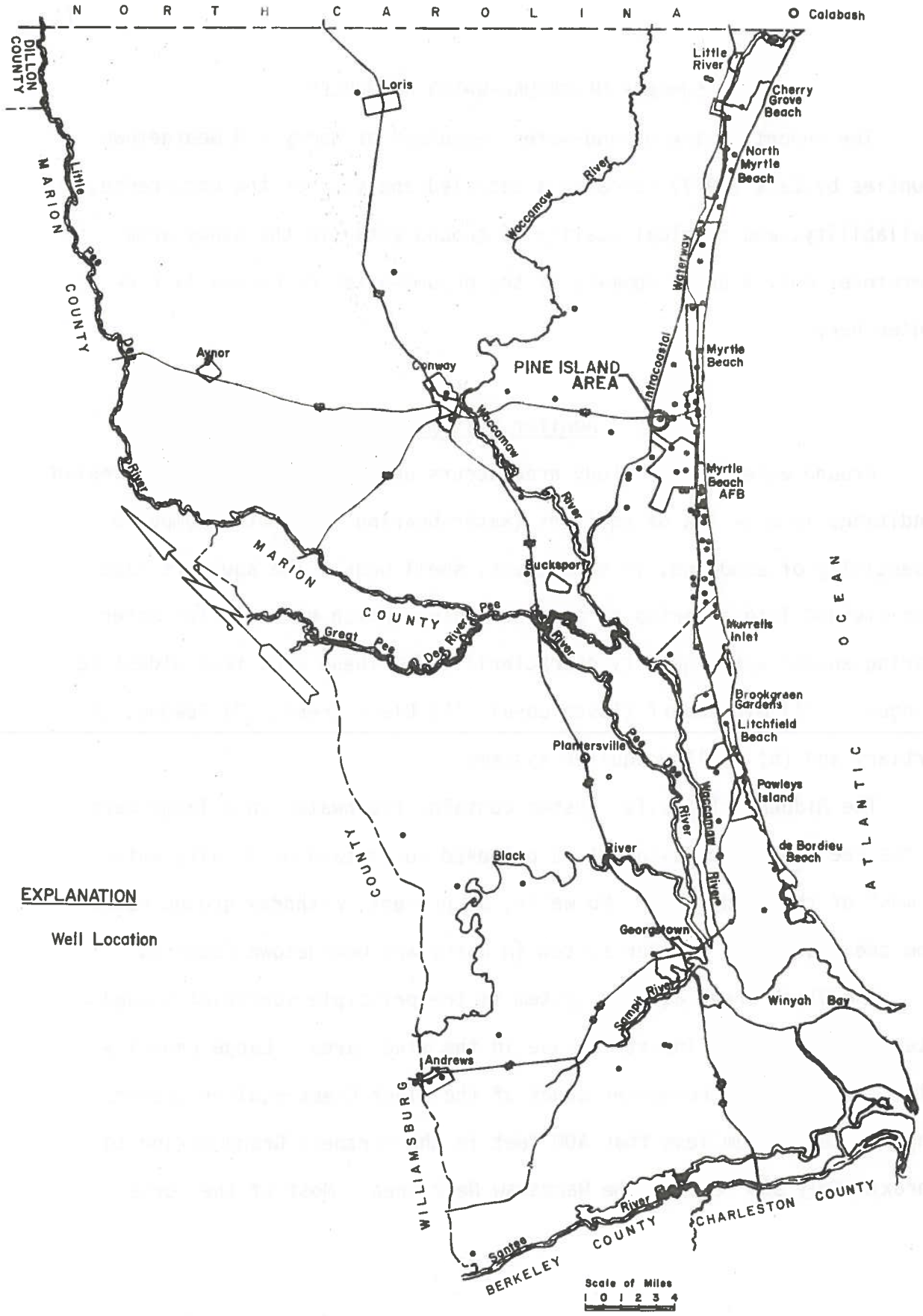

FIGURE 1. MAP SHOWING LOCATIONS OF PUBLIC AND INDUSTRIAL WELLS WITH RATED CAPACITY OF 100,000 GPD OR MORE WITHIN RECOMMENDED CAPACITY USE AREA BOUNDARY.

capacity wells shown on figure 1 pump solely from the Black Creek aquifer system and each of these wells has a rated capacity of over 100,000 gpd. Most large capacity and many low capacity wells along the Grand Strand are completed in what is herein referred to as the "principal sand aquifer" or simply the "principal sand" of the Black Creek aquifer system. Zack (1977) referred to the upper zone of the principal sand aquifer as the "heavily pumped, shallow Black Creek sand."

Large capacity wells have generally not been developed in the Peedee aquifer system. The hydraulic properties of the Peedee aquifer system in the study area are poorly known, but it is suspected that Peedee aquifers could probably supply as much water as the Black Creek aquifer system. Wells completed in the Peedee aquifer system would be shallower, making an attractive alternative or supplement to water pumped from the Black Creek aquifer system. Generally, the Peedee aquifer system is believed to contain relatively high concentrations of iron, calcium, magnesium, hydrogen sulfide and low concentrations of fluoride, dissolved solids, and chloride.

The Tertiary aquifer system contains shallow artesian aquifers composed of water-bearing sand and shell beds. Many rural residents throughout the two counties use small diameter, low cost wells developed in this aquifer system. Locally, wells less than 100 feet deep in the shallow artesian aquifers yield good quality water that generally contains low concentrations of fluoride, dissolved solids, chloride, iron, sulfate, and hydrogen sulfide. In some areas, especially in the Little River-North Myrtle Beach area, the shallow aquifers are the preferred source of drinking water for many residents because the deeper

artesian Black Creek aquifers contain excessive concentrations of fluoride, dissolved solids and chloride.

Shallow water-table aquifers occur within the Waccamaw Formation and various other shallow formations. Many shallow wells have been completed in the water-table aquifers for irrigation use, and water-table aquifers supply water to many shallow farm ponds which are utilized for irrigation.

Water Use

In Horry and Georgetown Counties, ground water is the principle source of water for domestic, public supply, and industrial use. The City of Georgetown uses surface water from the Pee Dee River to supply part of its water needs.

Complete records of water use in the area are unavailable because many water users do not monitor or keep records on the quantity of water used. However, a water-use study of the area completed by the Commission in 1975 indicates that the estimated average daily pumpage of ground water from about 100 municipal and other public supply wells and industrial wells in 1975 was approximately 10 mgd (million gallons per day). The largest pumpage occurs in the summer months (approximately 13 to 16 mgd) on the Grand Strand.

According to a recent study by the Waccamaw Regional Planning and Development Council (1977), the combined resident and tourist population of Horry and Georgetown Counties is expected to increase from 401,000 in 1976 to 804,000 in 1995. This population increase will create a corresponding increased demand for water. The peak daily demand for water in 1995 could approximate 25 mgd or more.

SUMMARY OF GROUND-WATER PROBLEMS

The purpose of this section is to summarize the ground-water problems identified during the Grand Strand Capacity Use Investigation. Following each ground-water problem is a brief discussion of conclusions and recommendations concerning the problem. These problems can be grouped under five major categories:

1. ground-water pumpage and water-level declines;
2. ground-water data collection;
3. saltwater encroachment;
4. well design and construction practices; and
5. water quality.

These problems are so interrelated that it is difficult to restrict a particular problem to one of the five major categories. However, in the following discussion, the problems have been restricted for brevity into one category.

Ground-Water Pumpage and Water-Level Declines

In Horry and Georgetown Counties, water levels in wells tapping the Black Creek aquifer system have been lowered as a result of years of ground-water withdrawals. Information collected from continuously monitored observation wells (non-pumping wells) during the Grand Strand Capacity Use Investigation indicates that water-level declines have occurred over a large part of the area.

Regional Water-Level Decline

A regional water-level decline indicates that the steady increase of ground-water pumpage is greater than the ground-water recharge to the Black Creek aquifer system. Hydrographs of monthly water-level measurements in two observation wells illustrate the continuous regional water-level decline (fig. 2).

Because of the complex hydrogeology of the Black Creek aquifer system, it is difficult to interpret water-level declines in single observation wells or even a potentiometric (water-level) map. Two factors that contribute to this difficulty are: (1) observation wells usually tap several sands and as a result, the measured water level is a composite of water levels; and (2) irregular pumping patterns on the Grand Strand cause seasonal water-level declines that obscure the water-level trend. However, by contouring the rate of change of winter water levels (thereby eliminating fluctuations caused by irregular pumping patterns) in observation wells, it is possible to identify areas of continuous water-level decline (fig. 3). Water-level declines of over 5 feet or more per year occur along the Grand Strand and declines of about 4 feet per year occur in the Conway area. Although the Black Creek aquifer system is capable of sustaining greater water-level declines (perhaps several hundred feet), the continual lowering of water levels has already caused and will continue to cause problems for residents in the area.

Increasing use of the Black Creek aquifer system by large water users will cause continuous water-level declines which will result in increased pumping lifts, lowering and/or replacing pumps, increasing pump-motor horsepower, and the abandonment of small-diameter domestic wells.

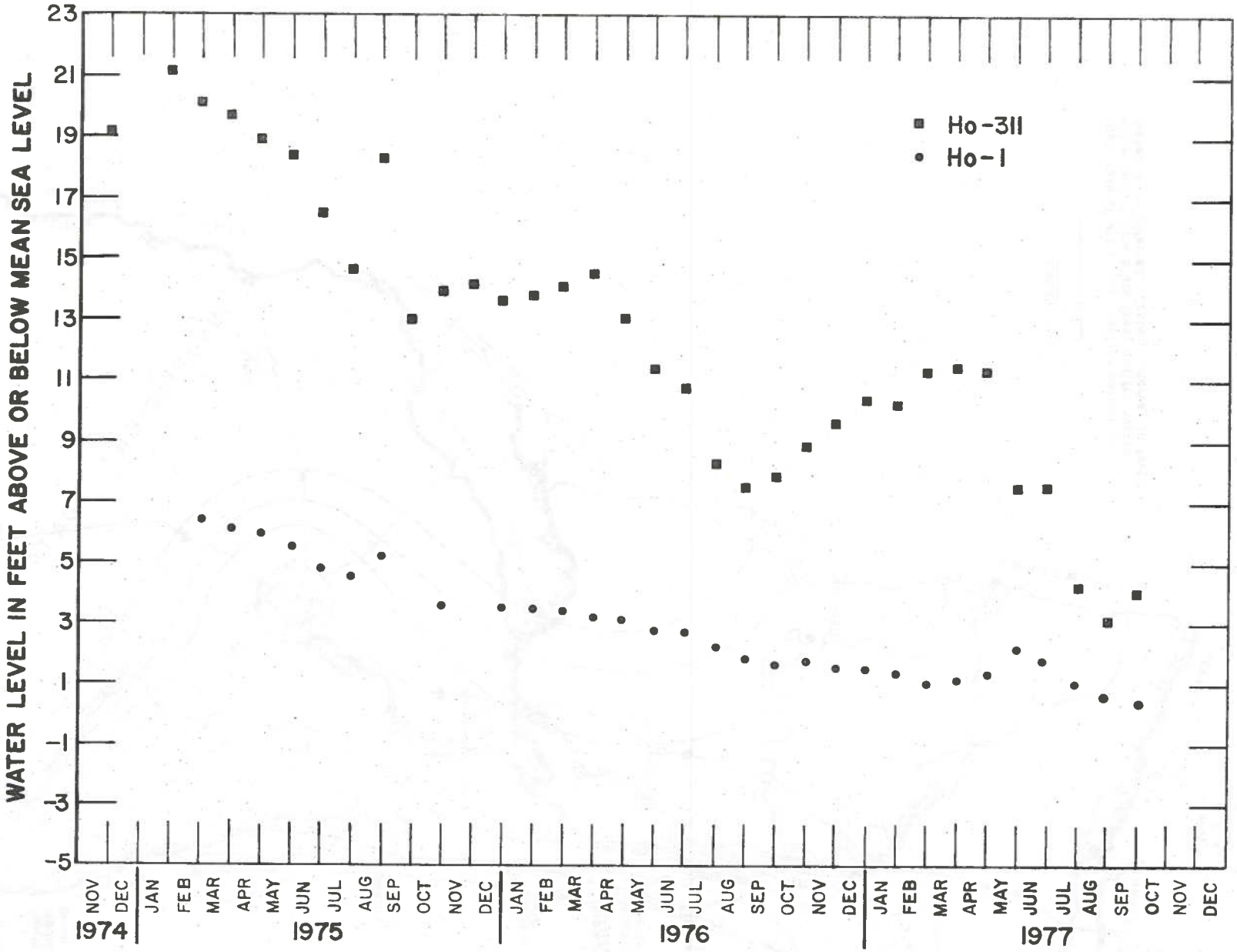

FIGURE 2. HYDROGRAPHS OF SELECTED OBSERVATION WELLS SHOWING REGIONAL WATER LEVEL DECLINE (HO-1) AND LOCAL CYCLICAL GROUND-WATER WITHDRAWAL PATTERNS (HO-311).

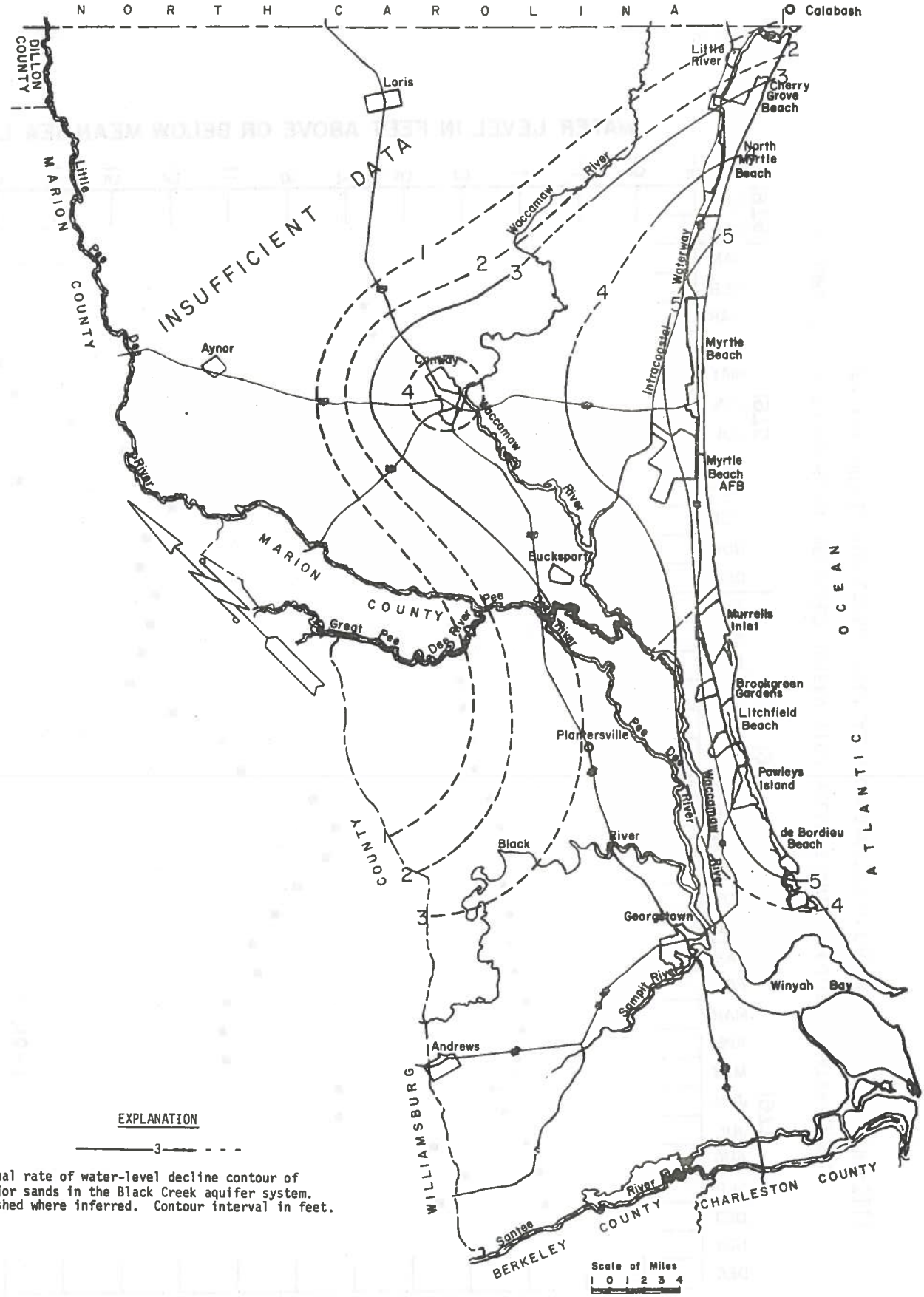

FIGURE 3. MAP SHOWING EQUAL RATE OF WATER LEVEL (POTENTIOMETRIC HEAD) DECLINE (IN FEET) OF MAJOR SANDS IN THE BLACK CREEK AQUIFER SYSTEM (FOR PERIOD 1976-1977).

Overdevelopment of the Principal Sand Aquifer

Potentiometric (water-level) maps of aquifers can be used to determine the direction of ground-water flow. Ground-water movement occurs down gradient and at right angles to water-level contours. A map showing the generalized potentiometric surface of the major sands in the Black Creek aquifer system for August, 1977, is shown in figure 4. As previously discussed, potentiometric data on the Black Creek aquifer system are difficult to interpret. However, two important observations are evident from figure 4: (1) a large cone of depression has developed along the Grand Strand; and (2) ground water is moving from the west, north, and northeastern Horry County (see "Saltwater Encroachment").

Superimposed on the major cone of depression are localized areas where the principal sand is overdeveloped. This problem is well illustrated in the Pine Island section of Myrtle Beach. Along a distance of one-half mile on Waterside Drive, seventeen domestic wells are completed in the principal sand aquifer (fig. 5). Well 6S-22 is a representative domestic well on Waterside Drive. When wells 6S-17 and 5S-T pump at different times (fig. 6A, 6B) well 6S-22 can pump water from the principal sand aquifer. During the summer months of 1975, 6S-17 pumped continuously and 5S-T pumped intermittently (fig. 6C). This pumping lowered the water level below the pump intake of 6S-22. Nine other wells on Waterside Drive were similarly affected. The South Carolina Water Resources Commission estimates that approximately $20,000 has been spent on pump replacements and new wells resulting from low summer water levels along this one street.

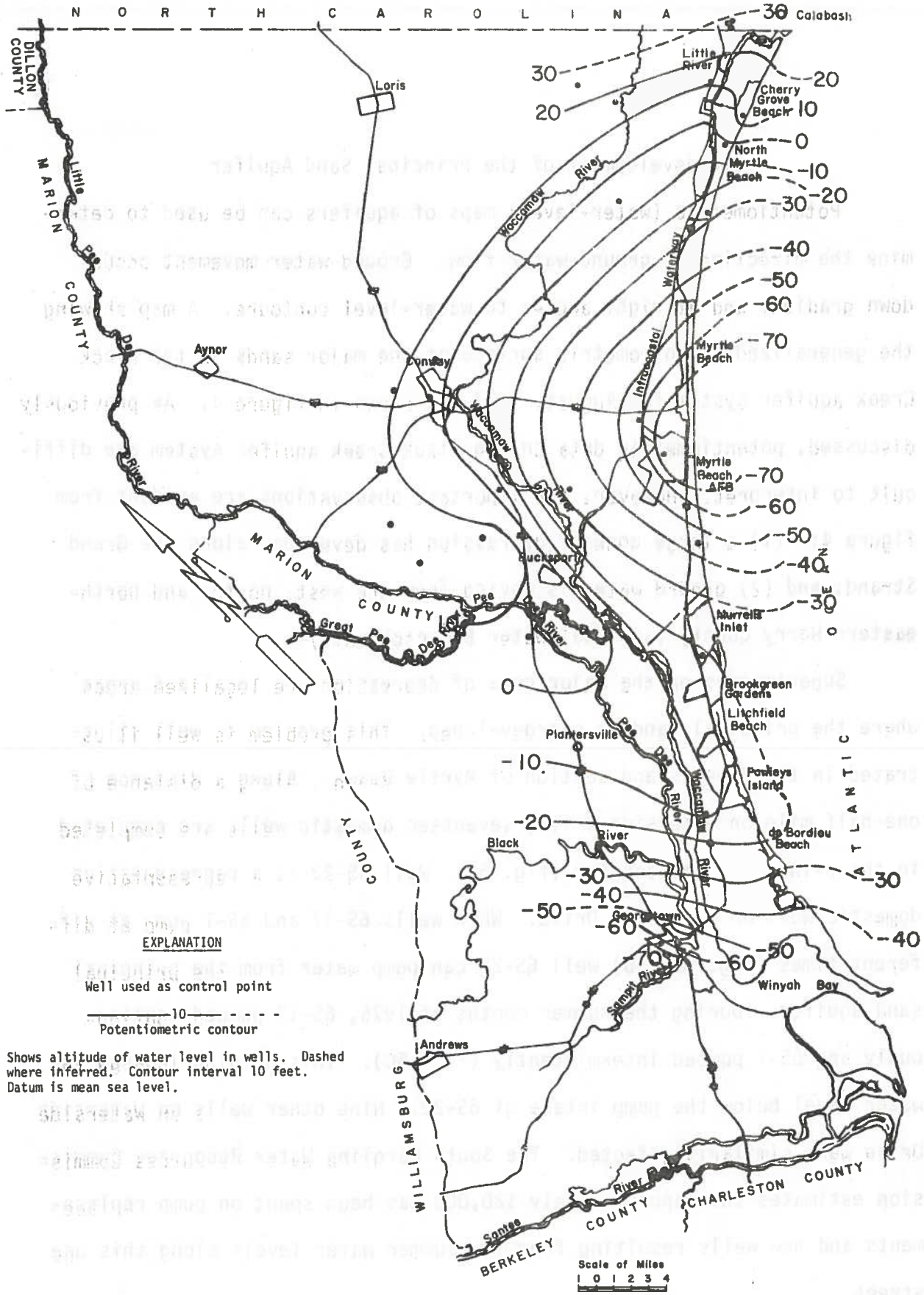

FIGURE 4. MAP SHOWING WATER LEVEL (POTENTIOMETRIC) SURFACE OF MAJOR SANDS IN THE BLACK CREEK AQUIFER SYSTEM, AUGUST, 1977.

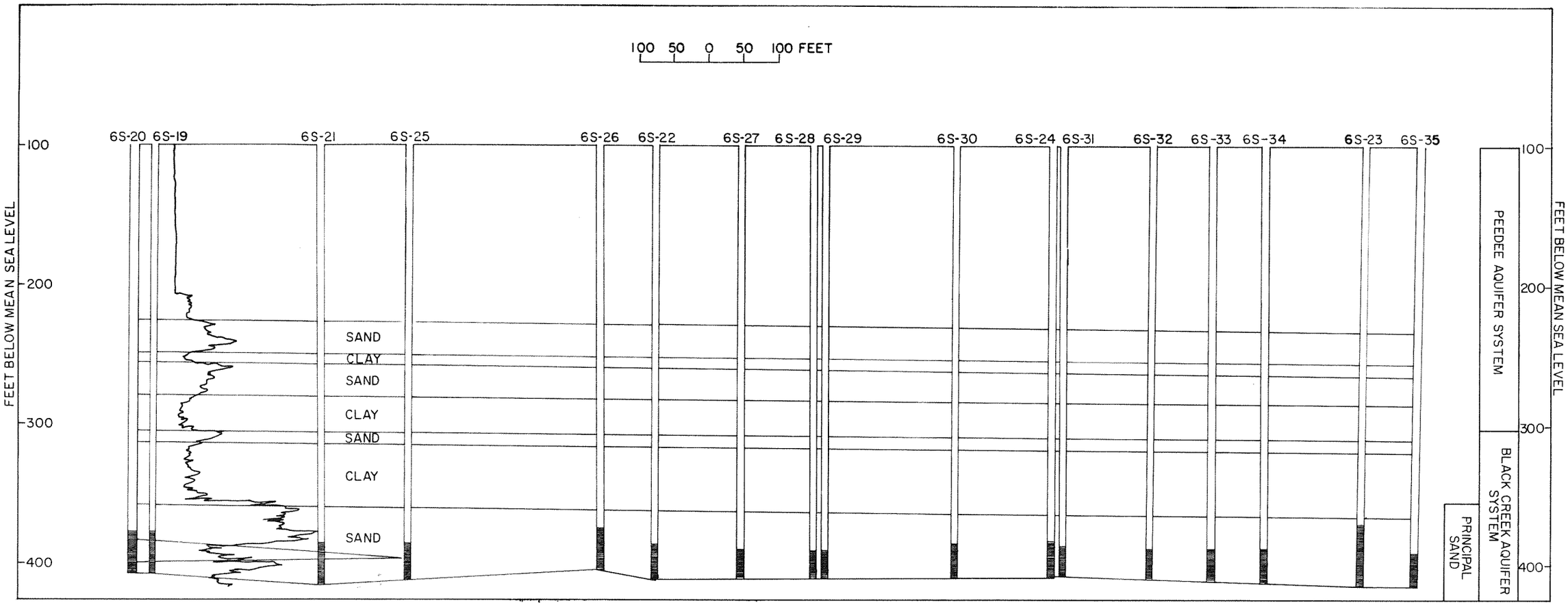

FIGURE 5. HYDROGEOLOGIC CROSS SECTION ALONG WATERSIDE DRIVE, PINE ISLAND SECTION, MYRTLE BEACH, S. C.

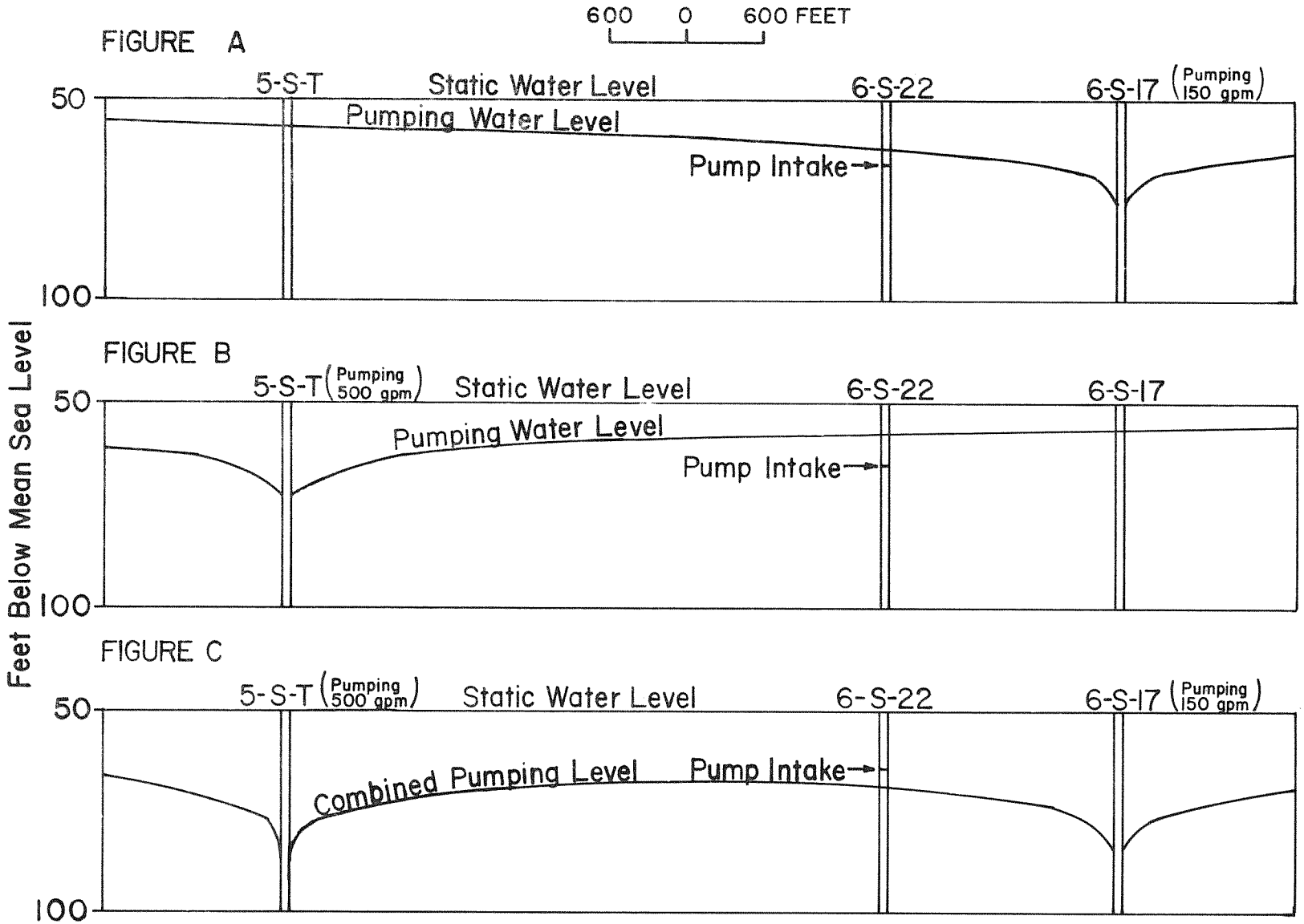

FIGURE 6. DIAGRAM OF CONES OF DEPRESSION DEVELOPED IN THE PRINCIPAL SAND OF THE BLACK CREEK AQUIFER SYSTEM, PINE ISLAND SECTION, MYRTLE BEACH, S. C.

As pumpage from the principal sand increases, equally severe overdevelopment problems are likely to occur in other areas of Horry and Georgetown Counties. Areas that will be most affected are where the permeability of aquifers is low. Proper spacing of wells and utilization of alternate aquifers for future water supplies would help alleviate the strain imposed on the heavily pumped principal sand and would reduce water-level declines. Currently there are no existing provisions to restrict the overdevelopment of aquifers.

Dewatering Operations

Large quantities of ground water are being pumped from a limestone quarry developed in part of the Tertiary aquifer system in rural southwestern Georgetown County. The water is being pumped from the limestone quarry by large capacity "sump" pumps as a dewatering program. The pumpage is reported to have contributed to water-level declines near the quarry, and the water level in several domestic wells has been lowered as a result of the pumpage.

Pumpage of ground water for dewatering operations constitutes a ground-water use and consequently should be considered under the regulatory provisions of the Ground Water Use Act.

Ground-Water Data Collection

Presently, except for public supply wells, well-drilling contractors are not required to maintain information on well depths, drilling logs on the thickness and characteristics of formation penetrated, and other information which could be available in evaluating ground-water resources. Of course, many well drilling contractors and engineers maintain accurate records and many of these records have been invaluable in this study.

However, test hole and well completion data on many wells are incomplete or unavailable. During the Capacity Use Investigation, engineers, well contractors and other individuals often requested ground-water data or assistance with well problems. In many cases, satisfactory data were not available even though one or more wells were located in the immediate vicinity.

Records of ground-water use in the study area are almost entirely lacking. Without such records it is difficult to estimate pumping cost, changes in well efficiencies, leakage from water distribution systems, and the effects of ground-water withdrawals on water levels. Such information is invaluable to municipal officials, waterworks engineers, consulting engineers and hydrogeologists. Provision for the reporting of water-use data are provided in the Act and should be established.

Conclusions and Recommendations

Interpretation of water-level and ground-water pumpage data suggests that: (1) water-levels are declining in the Black Creek aquifer system; (2) the lack of well depth and spacing requirements has led to the local overdevelopment of the principal sand in the Black Creek aquifer system with expensive consequences for many residents in the study area; and (3) failure to keep well completion records and water-use data has led to a serious lack of background data on the ground-water resources of the study area.

Proper sampling and testing procedures of all aquifers encountered during test drilling need to be established and enforced. The procedures would aid in establishing the proper sands (aquifers) to be developed and would help reduce regional water-level declines and local overdevelopment problems. Well spacing and depth controls on wells need to be established

to insure that aquifers are not overdeveloped. Use of alternative aquifers to the Black Creek aquifer system should be encouraged whenever possible. Provisions for the proper reporting of well completion and water-use data are needed so that well and water use data will be available. The analysis of these data will provide a continuous accounting system to evaluate the status of ground-water conditions.

Pumpage of ground water from quarries constitutes a ground-water use and should be subject to any permitting and management provisions established under the Ground Water Use Act.

Saltwater Encroachment

One of the concerns of local officials has been that the movement of salty water has degraded or may in the future degrade the freshwater aquifers of Horry and Georgetown Counties. Section 49-5-50(a)(2) requires consideration of provisions to protect against or abate saltwater encroachment. Therefore, one of the objectives of the investigation was to determine whether salty water was moving toward pumping wells and the magnitude of saltwater encroachment if found to exist.

Saltwater encroachment is one of the most complex and misunderstood concepts in ground-water hydrology. In general, saltwater encroachment is the slow, large scale movement of salty water into a freshwater aquifer and occurs either permanently or for a period of time measured in years. Saltwater intrusion is similar to saltwater encroachment but is generally considered as a small scale, temporary phenomenon. Both types of saltwater movement are caused by ground-water withdrawals located near salty surface water bodies (e.g. the ocean) or aquifers that already contain salty water from an earlier geologic time. Whether the movement of salty water into

a well or well field is temporary (intrusion) or permanent (encroachment), the result of this movement is freshwater degradation of water supplies. Therefore, for the purposes of the Act, saltwater intrusion is considered synonymous with saltwater encroachment.

Another type of freshwater degradation is that caused by saltwater contamination. Saltwater contamination, for the purposes of the Act, is the degradation of the quality of fresh ground water by lateral or vertical movement of salty water. Saltwater contamination of ground water may occur slowly or immediately, may be temporary or permanent or may be caused naturally or by the acts of man. Therefore, saltwater contamination includes saltwater encroachment and saltwater intrusion.

Salty water, for the purposes of this study, is water containing chloride concentrations of 250 mg/l (milligrams per liter) or more, the Environmental Protection Agency (EPA) recommended upper concentration limit for public drinking water supplies. The generalized distribution of salty water and freshwater within the Black Creek aquifer system is shown in figure 7. Salty water is a serious problem northeast of Myrtle Beach because fewer freshwater aquifers are available in the Black Creek aquifer system; northeast of Little River, for example, all sands within the Black Creek aquifer system contain salty water. This salty water is not sea water but is connate water--water entrapped in the sediments during the geologic past.

Since the detection and prevention of saltwater encroachment is of major concern to water users in the study area, it is important to predict saltwater movement or the potential for saltwater encroachment. It is known that for salty water to replace freshwater in an aquifer a hydraulic gradient from salty water towards the freshwater must be established. The presence of salty water in the Black Creek aquifer system (fig. 7) and the

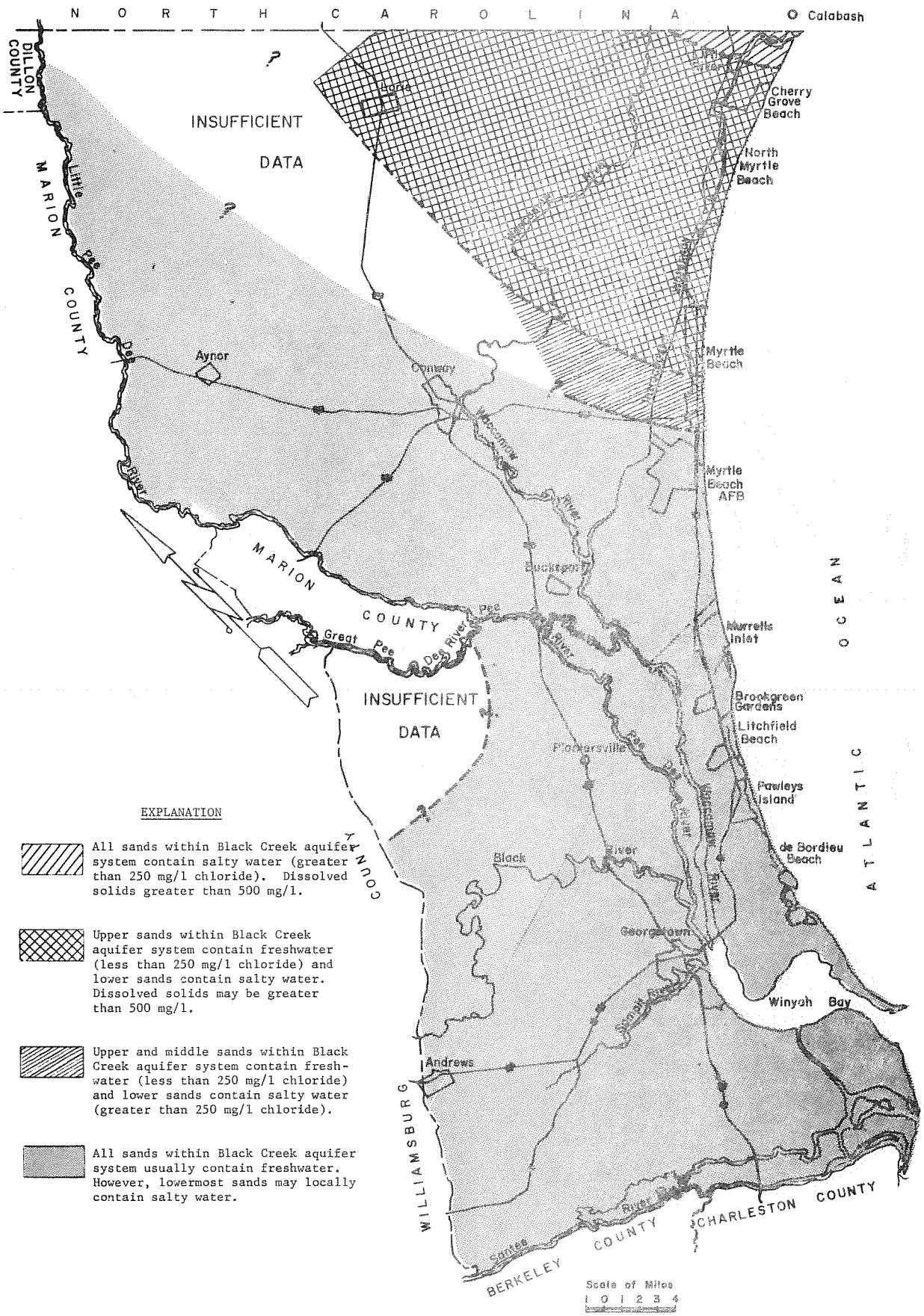

FIGURE 7. GENERALIZED HYDROGEOLOGIC MAP SHOWING THE AREAL DISTRIBUTION OF SALTY WATER WITHIN THE BLACK CREEK AQUIFER SYSTEM.

hydraulic gradient as shown in figure 4 indicate the potential for saltwater movement toward pumping centers located along the Grand Strand. In addition, the difficulties in measuring saltwater movement in a short period of time and in predicting the hydraulic gradient(s) that would be required to initiate saltwater movement point out the critical need for continual investigation and monitoring to detect saltwater movement. Since the potential for saltwater intrusion and encroachment has been documented, it is important that provisions to limit ground-water pumpage near areas of movement be established.

Saltwater Contamination

Individual sands within the Black Creek aquifer system contain freshwater throughout the study area except for the Little River-Calabash area (fig. 7). The occurrence of this salty ground water in the Black Creek aquifer system puts a limit on the availability of freshwater to individual wells on the northern Grand Strand. Excessive pumpage near the salty water could cause contamination of the aquifers.

In order to meet high well-yield requirements, salty sands are sometimes screened along with shallower, Black Creek freshwater sands. This has resulted in chloride concentrations in the mixed waters of greater than 250 mg/l in some cases. To prevent this contamination of freshwater aquifers, no well should be permitted to screen both saltwater and freshwater aquifers.

Contamination from Gravel-Filter Wells

Some gravel-filter wells along the Grand Strand produce high chloride water at the beginning of pumping, with the chloride concentrations decreasing within the first half hour of pumping. This chloride contam-

ination is the result of saltwater contamination of freshwater aquifers from gravel-filter well design. Zack (1977) reports that the gravel filter sometimes traverses a salty aquifer which locally occurs above the freshwater Black Creek aquifer system. The high hydraulic conductivity of the gravel filter and the higher potentiometric head of the shallow aquifers allow free movement of saltwater into the freshwater sands from idle or pumping wells.

To prevent saltwater contamination of freshwater sands, cement collars should be placed within the gravel filters between screened sands to provide impermeable seals between aquifers of unequal head and/or water quality. Electric logs (preferrably standard electric logs) would be needed to select the proper locations for cement collars. Gravel filters extending more than a few feet above the screened zones should be prohibited. After development and settling of the gravel, cement grout should be pumped from the top of the gravel to the surface between the open hole and casing.

Improper Well Abandonment Procedures

Throughout the study area, unsealed, abandoned wells are found near industrial, municipal and domestic wells. These improperly abandoned wells constitute a hazard to public health, safety and to the ground-water resources of the study area. An open well represents a direct conduit for potential contamination of a screened aquifer. In addition, abandoned wells are sometimes screened in saltwater and freshwater aquifers of unequal head (pressure). Therefore, the saltwater, generally of higher head than the freshwater, is permitted to flow into freshwater sands. Natural-filter wells can be plugged by pumping cement grout into the well.

However, gravel-filter wells without cement collars cannot be adequately sealed by simply pumping cement grout into the well. Therefore, the construction of gravel-filter wells without cement collars has led to the degradation of freshwater aquifers.

Flowing artesian wells, once commonly obtained throughout Horry and Georgetown Counties, are no longer commonplace. Many abandoned flowing wells, through years of non-use, have contributed to the overall water-level declines. These unused wells have needlessly wasted water, but more importantly, have wasted artesian pressures. Requirements for properly plugging or simply capping unused flowing wells would help conserve water and artesian pressures.

Conclusions and Recommendations

The possibility of saltwater movement toward pumping centers on the Grand Strand has been established. Provisions to manage ground-water withdrawals in areas near saltwater bodies should be established to protect against saltwater encroachment. In addition, research and monitoring of saltwater movement must continue in order to provide detection and warning of movement.

Saltwater contamination has occurred in Horry and Georgetown Counties from improper construction of gravel-filter wells and improper well screen placements. To prevent saltwater contamination of freshwater aquifers from improperly constructed wells, the following requirements are needed: (1) cement collars should be placed between aquifers of unequal head and/or water quality in gravel-filter wells; (2) at least single point (preferrably standard three point) electric logs of the test hole should be required before final approval of well specifications on gravel-filter wells; and (3) no well should be screened in both salty and fresh water.

In order to protect against the physical hazards of unsealed wells, to prevent freshwater contamination, and conserve the hydrostatic head (water levels) of aquifers, well abandonment procedures should be adopted and become part of all water-use permits.

Well Design and Construction

The improper design and construction of wells in the study area are responsible for many ground-water problems. These problems are: (1) the pumping of poor quality water; (2) the pumping of sand; (3) the use of inefficient wells; and (4) local aquifer contamination. Since many of these problems are presented in other sections of this report and in the companion report (Zack, 1977), these discussions will not be repeated here.

Conclusions and Recommendations

One of the principal findings of the Grand Strand Capcity Use Investigation is that well design and construction standards need to be established and enforced for all wells.

Water Quality

Large quantities of ground water are available in the study area but, unfortunately, part of this ground water is unacceptable for industrial, municipal or domestic use because it is heavily mineralized or contains high concentrations of certain ions.

The most troublesome chemical constituents in ground water in Horry and Georgetown Counties are: (1) fluoride, (2) chloride, (3) dissolved solids; (4) iron, and (5) hydrogen sulfide. Turbidity is also a water-quality problem.

Fluoride

Fluoride concentrations in ground water from the Black Creek aquifer system range from 0.9 to 5.5 mg/l. The highest fluoride concentrations occur within the principal sand aquifer from 100 to 250 feet below the top of the Black Creek aquifer system. As a general rule, water pumped from the Black Creek aquifer system exceeds the maximum contaminant level for fluoride concentrations (1.6 mg/l) as established by the Environmental Protection Agency.

Alternatives to the use of high fluoride ground water from the Black Creek aquifer system are: (1) the use of selective screening techniques where high fluoride zones are avoided; however, this reduces the amount of water available to the well; (2) mixing of low fluoride water (less than 1 mg/l) from the Peedee and shallower aquifers with water pumped from Black Creek aquifers; (3) use of the Peedee and shallower aquifer systems for water supply; and (4) defluoridation of ground water.

Chloride and Dissolved Solids

It has been determined that there is a direct relationship between concentrations of chloride and dissolved solids in ground water from the Black Creek aquifer system. As with chlorides, problems with dissolved solids occur as a result of improper well design and construction.

The distribution of chloride and dissolved solids in the Peedee and shallower aquifers is not well known. High concentrations of chloride and dissolved solids generally do not occur in these aquifers. However, salty water occurs locally in these aquifer systems.

Iron and Hydrogen Sulfide

Good quality water is available in parts of the Peedee and shallower

artesian aquifer systems in the study area. Water pumped from the aquifers has fluoride concentrations of less than 1 mg/l and could be used as an alternative to defluoridation of ground water from the Black Creeek aquifer. Ground water from the Peedee and shallower artesian aquifer system has significantly lower dissolved solids than that from the Black Creek aquifer system. However, in many parts of the area, iron and hydrogen sulfide sometimes occur in undesirable amounts in the Peedee and shallower aquifer systems.

Turbidity

Two types of turbidity problems have been observed in ground water pumped from the Black Creek aquifer system. Neither problem poses a health hazard, but the cloudy ground water is aesthetically undesirable.

A mud related carbonate precipitation problem is fairly widespread in the area. Apparently, the chemical interaction of drilling mud with hard water from shallow (less than 100 feet) aquifers and the subsequent loss of the drilling mud into the Black Creek aquifer system cause the problem.

A pressure related turbidity problem has been identified in ground water pumped from wells in parts of Williamsburg, Marion, Horry and Georgetown Counties. The chemistry of this carbonate precipitation is not well understood but is apparently a pressure dependent reaction.

Conclusions and Recommendations

Ground water pumped from the Black Creek aquifer system generally exceeds the maximum contaminant level for fluoride. Alternatives to defluoridation of Black Creek water are the development of the Peedee and shallower aquifer systems. Water pumped from the Peedee and shallower

aquifers could be mixed with water pumped from the Black Creek aquifer system or used directly as a source of low fluoride water. Ground water from the Peedee and shallower aquifers contains significantly lower concentrations of dissolved solids than deeper aquifers, but the water may require treatment for the removal of iron and hydrogen sulfide.

REVIEW OF EXISTING LEGISLATION AFFECTING GROUND-WATER USE

Introduction

The Ground Water Use Act provides certain regulatory remedies which the Commission, in its discretion, may implement upon declaration of a capacity use area (see specifically Section 49-5-50, 60). In addition, the Act (Section 49-5-40(c)(2)) requires an assessment of existing methods to solve or minimize ground-water problems short of implementing capacity-use restrictions. A fair reading of this section requires the Director to evaluate the ground-water problems identified and the adequacy of existing legislation to correct such problems.

While there are numerous local, State and federal laws which regulate, or could regulate upon full implementation, certain aspects of the use and consumption of ground water, the Ground Water Use Act is the single State statute dealing exclusively with ground water. The Act may also be considered exclusive in its express limitation on the riparian right to withdraw ground water in capacity-use areas under certain circumstances.

The following section identifies local, State and federal statutes and ordinances affecting the use or consumption of ground water. Some statutes regulate certain aspects of ground water by implication, others by express provisions. Because many of the statutes appearing below are general, rather than specific in purpose, an attempt is made to focus on the primary purpose of the acts as they affect ground water.

Water Use Act, water wells for single residences.

Federal laws, other than those federal standards adopted through State legislation, do not comprehensively address the ground-water problems for which the Ground Water Use Act seeks remedy. The sole source aquifer provisions of the Federal Safe Drinking Water Act would not appear applicable to the study area, nor do those provisions apply to non-federally financed water projects or supplies.

Several programs administered by State agencies have some impact, both direct and indirect, on ground-water use or consumption, and to that extent, should be considered as provided in Section 49-5-40(c)(3) of the Ground Water Use Act in declaring capacity-use areas and implementing subsequent regulations. Several agencies, not directly regulating ground-water use, would have interests in capacity-use restrictions, ground-water management programs, or ground-water data collection.

The Mining Council has experienced periodic problems concerning land collapse and well dewatering in and adjacent to permitted mining operations. Any dewatering operation could present a substantial ground-water use impact and such withdrawals are subject to the capacity-use provisions. Therefore, mining permits and any ground-water pumpage conditions they might contain should be considered in the implementation of capacity-use restrictions.

Implementation of capacity-use provisions should have little direct impact on the South Carolina Coastal Council's present regulatory program. However, implementation of the Ground Water Use Act within any portion of the eight-county area, should be considered to be of substantial planning interest to the Coastal Council, both in the information acquired and management decisions made. If a capacity-use area is declared within the

coastal counties, a system of coordination with the Coastal Council should be considered, providing appropriate review of jointly relevant programs or program decisions.

Several programs administered by DHEC impose regulations directly affecting ground water. Such regulations fall into two general classes: (1) those for the purposes of preventing pollution and (2) those for the purposes of protecting public health by regulating public drinking water systems. Under the State's pollution laws, substantial attention is given to the regulation of point-source discharges and waste or garbage leachates. Recent programs have concentrated on the monitoring of shallow ground water at sanitary landfills, sewage lagoons and other potential pollution sites. These activities, while of significant bearing to ground-water management within potential capacity-use areas, are beyond the scope of regulations encompassed in the Ground Water Use Act. A source of pollution is recognized in the report from numerous open and abandoned wells. While such wells may not per se violate present regulations (but see (7)(a) above), discharges of pollutants into such wells, absent a permit, could constitute a violation of present regulations. However, a form of pollution, neither a discharge nor leachate, which has been identified within the study area, is that of saltwater encroachment. As described in previous sections, saltwater encroachment has been identified in several different forms, with separate causes, sources and remedies. Remedial and precautionary regulations suggested include timing, spacing and ground-water withdrawal controls. Saltwater encroachment and the measures to abate such encroachment are not typical of point or non-point source discharge problems. As such, saltwater encroachment has not been addressed in the existing and usual pollution control regulations of the State.

Regulations administered by DHEC concerning public health and drinking water standards, however, direct, or have the possibility of directing, more substantial attention to ground-water problems identified in this report. A major problem involves the use of poor quality drinking water. Under the State Safe Drinking Water Act, regulations presently in effect prohibit the use of ground water of sub-standard quality. Well construction standards for public supply wells are being drafted by DHEC and it is anticipated that some of the water-quality problems will be addressed in these forthcoming DHEC regulations. While it is not possible to specify the complete range of problems and regulations anticipated under the Drinking Water Act, cognizance of the requirements on the drinking water systems, of the administrative capabilities of DHEC, and of the existing data requirements should be considered in promulgating regulations in a designated capacity-use area.

Some caution must be taken in comparing the purposes of the Safe Drinking Water Act and Ground Water Use Act and the administrative remedies under both. While the subject matter of regulations under both acts could be functionally the same, ie., ground water, the purposes for the imposition of such regulations are substantially different. The purpose of the Drinking Water Act is to protect public health by regulating the quality of drinking water provided by public waterworks systems. The purpose of the Ground Water Use Act is to assure the beneficial use of ground water and to provide for rational conservation and development of the State's aquifers. Therefore, the acts should not be considered competitive but complementary in purpose.

In summary, certain of the problems identified, appear to be capacity use type problems, remedies for which appear, or can be implied, in no

other existing State, local, or federal act. Specifically, problems relating to water-level declines, saltwater encroachment, non-drinking water wells, including location, development, and construction practices, and perhaps most significantly, ground-water use controls, regardless of their character, seem to be capacity use, rather than pollution or public health problems. Several of the capacity-use requirements could be incorporated into existing or potential DHEC regulations, specifically those of mutual concern with water quality, well design and construction and informational requirements. Joint assistance in enforcement of ground-water concerns might be desirable.

The following recommendations should be considered if a capacity-use area is declared in the study area:

1. There appears no local, State, or federal law, persently implemented, which is capable of providing appropriate remedies for all of the ground-water use and management problems addressed in this report. While certain voluntary and public information programs would assist in the implementation of a ground-water management program, especially with attention to providing detailed technical information to local officials, engineers, water well drillers and individuals, many problems are sufficiently serious and/or regional in nature to require regulatory action.
2. Under certain circumstances, local agencies, the Land Resources Conservation Commission and the Coastal Council in administering their statutory responsibilities, would

be interested in, if not benefited by, the implementation of a ground-water management program. Continued and close coordination between the Water Resources Commission and the State agencies, as well as local governmental and planning agencies, should be considered an important aspect of a capacity-use declaration.

3. The Department of Health and Environmental Control administers statutes and regulations affecting ground water for pollution control and public drinking water systems. Such laws have direct bearing on ground-water management, but are not intended to address all of the problems associated with ground-water use. Existing or potential DHEC regulations would require permits for certain ground-water related activities. Where appropriate and ageeable to the agencies, regulations of mutual concern should be incorporated into existing permit provisions. Future regulations by both agencies should be coordinated to assure non-duplicity. In the administration of permit requirements, consideration of joint application, issuance or enforcement procedures should be made, where appropriate. Existing coordination of data collection should be continued and strengthened.

GROUND-WATER MANAGEMENT AND ECONOMIC IMPLICATIONS

Despite an overall abundance of ground water in the study area, there is sufficient evidence to indicate that a coordinated, comprehensive ground-water management program is needed to protect the ground-water resources of the area.

Ground-water management can be simply defined as the process of achieving the optimum beneficial use and protection of our ground-water resources. The methods used in ground-water management vary considerably but basically can be divided into (1) voluntary methods and (2) regulatory methods. The most desirable, of course, would be voluntary methods--wherein steps and procedures would be initiated by water users to properly develop and utilize freshwater aquifers to achieve the optimum beneficial use of those aquifers. Unfortunately, our ground-water resources are not infinite and water use conflicts often arise; regulatory provisions are often necessary to provide for proper ground-water mangement.

The essential elements of a ground-water management program can be summarized as follows:

1. Adequate technical data and knowledge to understand the occurrence, movement, use and quality of ground water.

2. Technical competence in analyzing these technical data and adequate staff and funding to administer the management program.

3. Legal/legislative authority, where necessary, to provide reasonable management regulations. Continual coordination must be maintained among local, State and federal officials to avoid unnecessary

duplication of effort.

4. Input, support and understanding of the objectives of the management program by local officials and residents.

5. The management program must be reasonable, flexible and adaptable to changing hydrologic, economic and social conditions.

In the study area, elements (1) and (2) have been in part achieved by the Grand Strand Capacity Use Investigation. However, ground-water conditions are constantly changing and a data collection and monitoring program must be continued if we are to develop an adequate ground-water management program. The Commission through cooperative agreements with the United States Geological Survey, Coastal Plains Regional Commission, and local governments has initiated the type of technical data collection needed to properly manage the ground-water resources.

Legislative authority to develop ground-water management provisions is provided in the Ground Water Use Act and the State Safe Drinking Water Act. Continual coordination must be maintained among local, State and federal officials in order to develop a comprehensive ground-water management program.

These legislative acts, properly utilized, are management "tools" and the objectives of the management program must have the understanding, input, and support of local officials and residents. With this input and understanding a management program can be devised which will be reasonable and flexible. To be sure, conflicts will occur as demands on our water resources increase, but conflicts can at least be rationally addressed with a comprehensive ground-water management program.

In analyzing the ground-water problems and in recommending voluntary or regulatory controls, the Executive Director and staff of the Commission have placed emphasis on analyzing the economic implications of recommendations contained in this report. It is felt that rules and regulations promulgated under the Act should not be unnecessarily expensive to water users or the regulating authority. It is impossible to estimate, at this time, the economic effects and implications of all recommendations contained in this report. It is anticipated at this time that regulations, if similar to capacity-use regulations in other states, will not cause unreasonable constraints on water users, well-drilling contractors or others engaged in ground-water work.

Adequate and proper well spacing and depth requirements, well-construction standards, well and aquifer testing procedures and the maintenance of well and water-use reports are usually recommended water-supply engineering principles.

The placement of cement collars in gravel-filter wells could raise the initial investment cost of the well. However, if this investment prolongs the life of the well and protects the aquifer, then the investment is not unreasonable.

The maintenance and submission of well and water-use reports pays dividends to water users because the assembled and evaluated data become part of an information bank that is available to all water users. Practically every municipal and industrial water user in the study area has already benefited from the technical data compiled during this investigation. The data have also benefited consulting engineers, water-well contractors and many individuals.

As reported by Zack (1977), "This report documents that in spite of

numerous problems, large quantities of undeveloped ground water are available. However, the life of the Black Creek aquifer system and other aquifers are dependent upon sound management and conservation practices." The technical data now available should provide the foundation for a reasonable ground-water management plan and ground-water problems can be rationally and comprehensively addressed.

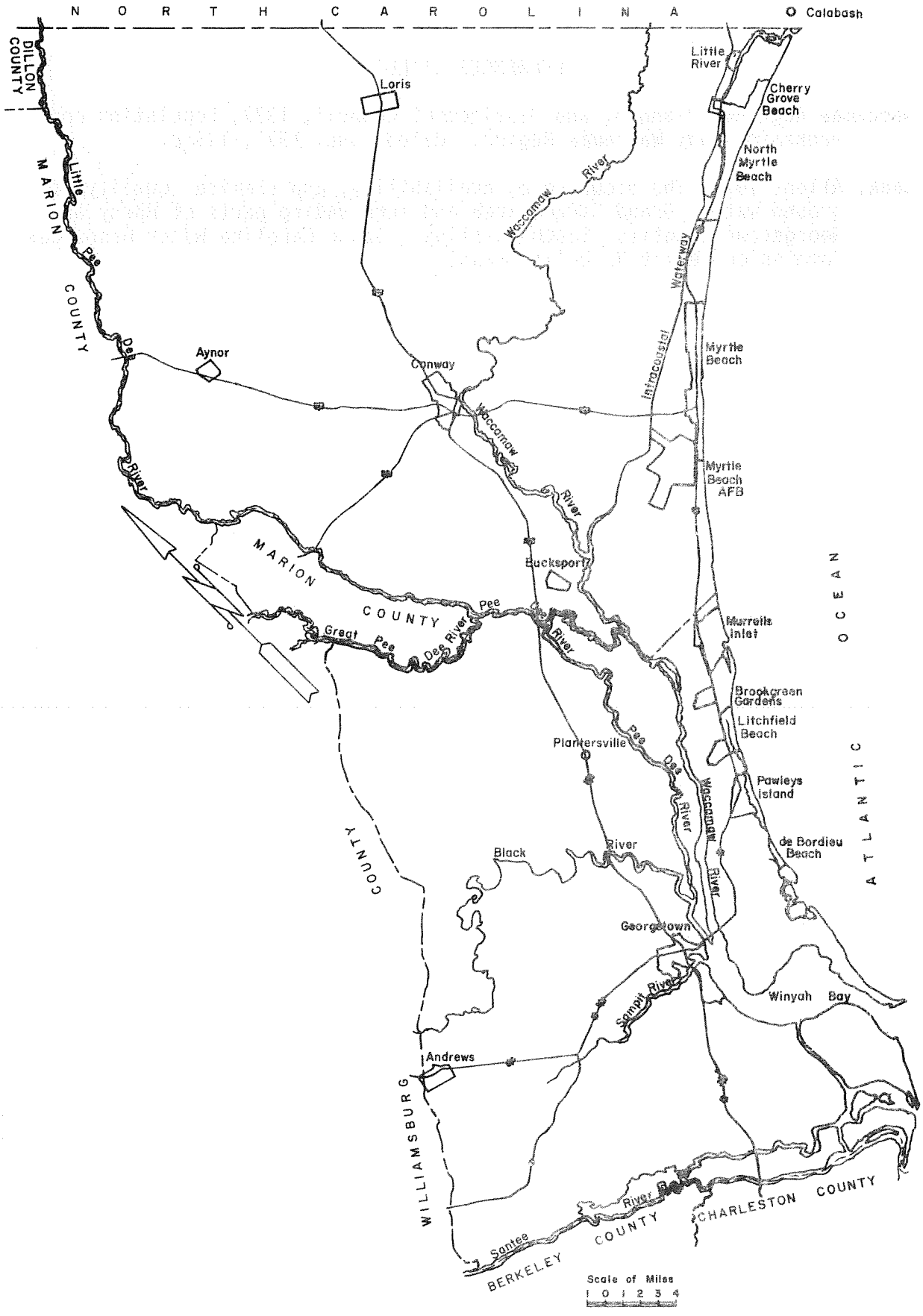

FIGURE 8. MAP SHOWING RECOMMENDED BOUNDARIES OF THE CAPACITY USE AREA.

REFERENCES CITED

Waccamaw Regional Planning and Development Council, 1977, Population and economic study Waccamaw Region: dated June, 1977, 105 p.

Zack, Allen, 1977, The occurrence, availability, and chemical quality of ground water, Grand Strand area and surrounding parts of Horry and Georgetown Counties, South Carolina: South Carolina Water Resources Commission Report No.8 (in press).

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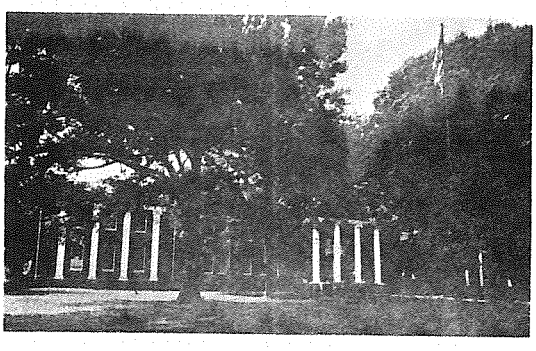

James P. Stevens, Senator
House of Representatives

John Jenrette
Sidney Floyd

Charles Hodges
Phillip Sasser

M. W. Dusenbury, Executive Secretary

Horry County Legislative Delegation

P. O. Box 36
Conway, South Carolina 29526

March 6, 1972

Mr. Harry S. Bell, Chairman
South Carolina
Water Resources Commission

Mr. Clair P. Guess, Jr.
Executive Director
South Carolina
Water Resources Commission
2414 Bull Street
Columbia, South Carolina 29201

Dear Sirs:

We, the undersigned, do hereby formally request the South Carolina Water Resources Commission to implement the provisions of the Ground Water Act of 1969. In doing so we are requesting that your Commission make a capacity use area investigation of the water bearing aquifers which underlie Horry County and surrounding areas.

We firmly believe that the continued and accelerated development and use of this valuable resource is gradually approaching the point that the continued unmanaged use will ultimately lead to a gradual deterioration of the resource.

We further believe that this most necessary step is required in order to protect the existing interests, rights and investments of individuals and municipalities in our county.

In making this request we will be most happy to cooperate during the capacity use area investigation by providing those available resources at our disposal.

We would like to schedule a meeting as soon as possible in order to discuss the ways and means of implementing this request at the earliest possible date.

Sincerely,

Senator James P. Stevens

Sidney T. Floyd, House Member

Charles E. Hodges, House Member

John W. Jenrette, Jr., House Member

Phillip D. Sasser, House Member

gaa

APR 18 1972

Georgetown County Board of Commissioners
P. O. DRAWER C
Georgetown, S. C.
29440

April 14, 1972

Mr. Harry S. Bell, Chairman
South Carolina
Water Resources Commission

Mr. Clair P. Guess, Jr.
Executive Director
South Carolina
Water Resources Commission
2414 Bull Street
Columbia, South Carolina 29201

Dear Sirs:

It has come to our attention that Horry County has formally requested that you carry out a Ground Water Survey and prepare a Ground Water Use Plan under the provisions of the Ground Water Act of 1969. We understand that because of well water problems the first emphasis of this work will be in the Grand Strand area.

Almost half of the Grand Strand is in Georgetown County and we are having serious problems with well water supplies.

We formally request that the Grand Strand portion of Georgetown County be included in the Ground Water Survey and planning work along with your Horry County activity.

We would like to know what additional steps we should take to assure being included in this survey work.

Sincerely yours,

Alfred B. Schooler

Alfred B. Schooler, Chairman
Georgetown County Board
of Commissioners

ABS:la