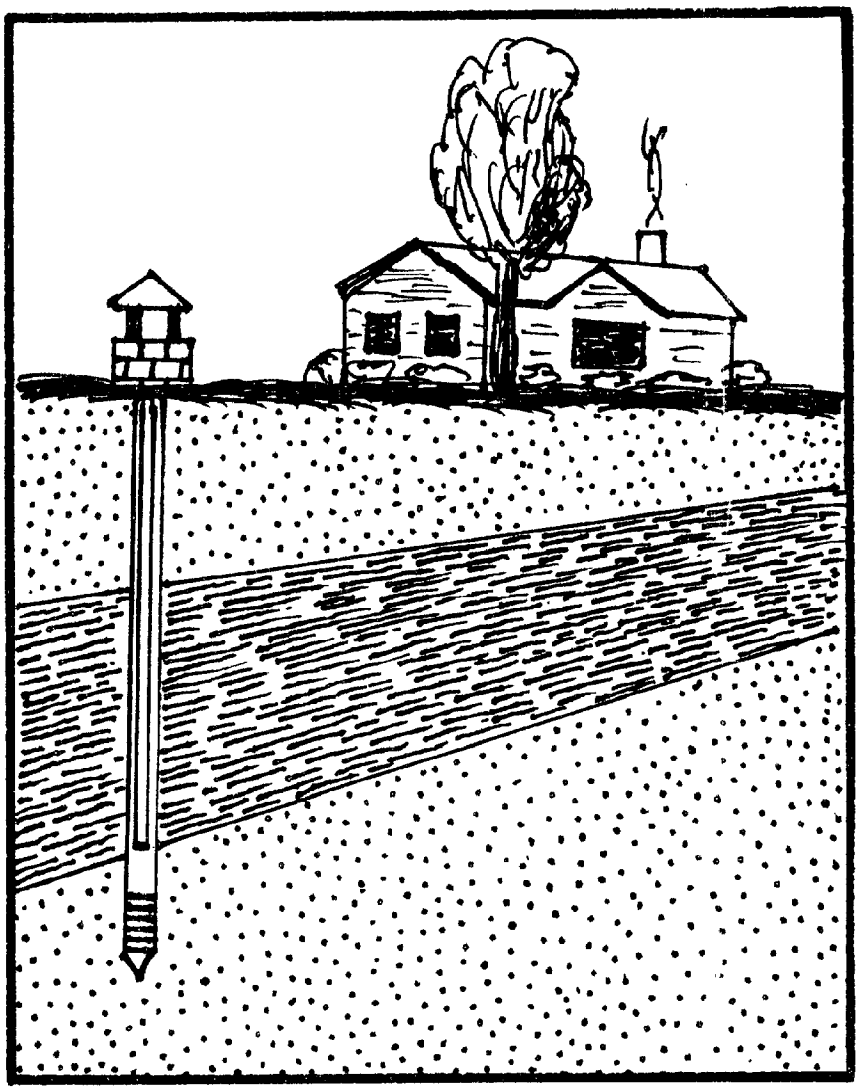
NEW HANOVER COUNTY
AQUIFER MANAGEMENT PROGRAM



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NEW HANOVER COUNTY

AQUIFER MANAGEMENT PROGRAM

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AQUIFER RECHARGE BOUNDARY STUDY: NEW HANOVER COUNTY

Introduction

This report supplies technical information and appropriate interpretations relevant to the delineation of aquifer recharge boundaries. It fulfills the subcontract between New Hanover County and the writer in providing background information that can be used by New Hanover County Planning Department in management strategy for the primary aquifer recharge area.

The definition and delineation of the primary recharge area are so complex that it was considered necessary to enlarge the scope of the study to describe various aspects of recharge areas in the County. To some extent, sensitivity of aquifers to contamination and to other harmful effects by human action is a more useful overall objective. Since "aquifer sensitivity" is a broader and more inclusive term than "protection of aquifer recharge area," much of the report is directed to aquifer sensitivity throughout the County. The information in the report should be useful beyond the intended scope; it should be in harmony with the administrative and legal responsibilities of the County Planning Department.

Existing reports and available data have been evaluated for the study. The North Carolina Department of Natural Resources and Community Development is collecting valuable ground-water data in the County, and Mr. Rick Shiver has graciously provided appropriate information. It appears, however, that the report entitled "Geology and Ground-Water Resources of New Hanover County, North Carolina" by George Bain provides much of the key information needed for this study. More specifically, figures 13 and 17 of the Bain report are sufficiently accurate and are expecially suited for part of the objectives here. Figure 5 of the Bain report is produced here as figure 1 so that key ground-water conditions can be put in focus readily.

In a sense, a recharge area is almost the entire land surface, and, therefore, the potential, or ultimate, recharge area covers almost the entire county. Many issues and aspects of recharge areas in general and in New Hanover County in particular are discussed.

Figure 2 is an aquifer sensitivity map of the County showing also various recharge features; it delineates primary and secondary recharge areas. In order to adjust the discretionary hydrologic boundaries to property boundaries and to other distinctive boundaries, figure 3 was developed. It is in agreement with the boundaries prepared by County Planning Officials.

Aquifers and Recharge Areas in New Hanover County

Some general statements and definitions are necessary to clarify the complex situation and to prevent misunderstandings. As considered here, the principal aquifer is the composite aquifer system of the Castle Hayne Limestone and underlying Peedee Sandstone where the Castle Hayne is also overlain by a shallow water-table sand aquifer, as shown in figure 1. The principal aquifer as defined here represents generally the area where both the Castle Hayne and Peedee aquifers contain fresh water under confined rather than water-table conditions. It corresponds generally with, but is slightly larger in area than, the area referred to as the primary recharge area.

The primary recharge area corresponds with high positions of the potentiometric surface (high positions of the water levels of both the Castle Hayne and Peedee aquifers). The nature of this recharge area needs to be fully understood for the purpose of land and water use planning.

First, this primary recharge area has an indirect response rather than a direct response to replenishment, or recharge, of water. The primary recharge area

has a fine sand water-table aquifer just below the land surface and above the Castle Hayne. In the vertical sequence the following conditions prevail: (1) a fine sand water-table aquifer at the land surface that absorbs the recharge (water from precipitation), (2) an underlying thin layer of finer sand or clay that generally separates the shallow water-table aquifer from the underlying (3) Castle Hayne Limestone aquifer. Below the Castle Hayne aquifer in most places is a (4) clay zone that separates the overlying Castle Hayne Limestone aquifer from (5) the Peedee Sandstone aquifer. Even though the Castle Hayne and Peedee aquifers are mostly separated by a clay bed, they are considered here as a composite, or principal, aquifer.

Recharge areas are characterized by high ground-water levels. If emphasis is on only a shallow water-table aquifer, most of the ground surface represents the recharge area, and only the stream valleys might be considered natural discharge areas. If emphasis is on recharge to a confined, or artesian, aquifer, recharge can occur from an overlying water-table aquifer where the water table is higher than the artesian water level of the artesian aquifer; in this case, water moves downward slowly through upper clays or other confining beds. Recharge may be considered as indirect since the precipitation passes through the overlying water-table system first.

With the thoughts above in mind, let us look at the Castle Hayne and Peedee aquifers. The primary recharge area as shown on figure 2 (Area 1) represents indirect recharge because water from precipitation passes downward through the water-table aquifer and the upper clay or fine sand bed before reaching the composite Castle Hayne-Peedee aquifers. In this case, the indirect recharge is a blessing because it makes the aquifer less sensitive to surface contamination than if the aquifers were exposed at the land surface, as they are in Area 2.

Also favorable is the fact that the clays or fine sands separating the shallow water-table aquifer from the underlying Castle Hayne are not completely impermeable and thus allow water to pass downward to the principal aquifer; without this "leaky aquifer" situation, as hydrologists consider it, the Castle Hayne and Peedee aquifers could not be adequately recharged.

For the purpose of distinction here, Area 2 may be considered the secondary recharge area; however, it is an important recharge area and not necessarily subordinate to the primary recharge area. It is the area in which the Castle Hayne aquifer and/or the Peedee aquifer are generally under water-table conditions and are subject to direct recharge from precipitation. The boundary with other areas is discretionary and not precise. Since the aquifer is near land surface and exposed directly to infiltration and recharge, the aquifer in area 2 is sensitive to contamination. An exception to the general agreement between the water-table parts of the Castle Hayne and Peedee aquifers and Area 2 is the sandhill region south of Wilmington near the Cape Fear River. This sandhill region has a water-table aquifer in the surface sands and contains the Peedee Sandstone aquifer under artesian conditions. On figure 2 this sandhill region is in Area 3 whereas this region is a part of the secondary recharge area on figure 3.

Area 4 represents in a general way the natural discharge area for the water-table parts of the Castle Hayne and/or Peedee aquifers. Some of this area could be converted to a recharge zone only if wells or quarries near the surface stream lowered the water table sufficiently to reverse the flow - water from surface stream into the aquifer and also into the cone of pumping depression rather than the natural flow of ground water toward the stream.

General Considerations for Land Use Planning in Areas 1 and 2

In Area 1 (the primary recharge area) the principal aquifer (Castle Hayne and Peedee) is fairly well insulated from surface contamination. Conventional septic tank effluent and accidental spills of contaminants are generally dissipated in the shallow water-table sand aquifer. With the very small pumping from this aquifer now, only a part of potential recharge reaches the principal aquifer; much of the potential recharge is not needed and, therefore, shunted out to discharge in the shallow sand water-table system. If heavy pumping of the principal aquifer were to start and continue for perhaps 30 years, there might be some movement of contaminants downward to this aquifer from the land surface. This is only a possibility, and if it were to happen, the problem could be detected early before serious damage is done. Normal suburban expansion and small businesses with no significant waste problems probably should not lead to an aquifer contamination problem. Even though the aquifer is somewhat insensitive to contamination, it might be wise to keep out of Area 1 sanitary landfills and industries having significant handling of toxic materials.

Recharge to the principal aquifer in Area 1 will be reduced slightly as human drainage operations increase. At the present, the past surface drainage changes have had very little effect because such a small percent of the total water available to the aquifer is used. Also, the easy access of water from precipitation into the surface sands over wide areas should assure ample recharge to the principal aquifer even if there is appreciable pumping of water from it. The quantity of water available for recharge to the principal artesian aquifer (Area 1) is not likely to be reduced significantly unless human action to divert surface runoff from the area increases greatly.

It should be noted on figure 2 that Area 1 is surrounded by discretionary areas (1 or 2 on the west and 1 or 6 on the east). Whether these border areas should be considered a part of Area 1 is probably a judgment decision. In order to adjust the boundaries to appropriate geographical and property boundaries suitable to Planning Officials the boundary of the primary recharge area is modified as shown in figure 3.

In Area 2 the principal aquifer is near land surface and mostly under water-table conditions. Recharge is more direct than in Area 1, and the potential for contamination is greater. The overall potential for ground-water development is somewhat less than in Area 1, chiefly because the aquifer is relatively thin (in most places only the Castle Hayne or Peedee aquifer is present).

In Area 2 consideration should be given to zones or sections where the water yielding capacity of the aquifer is fairly high but where contamination has not yet reached a serious problem. Area 2 north of Smith Creek is such an area that needs some protective measures because it is a sensitive area for contamination.

Notes on Additional Areas in the County

Although not a specific part of this subcontract, additional areas of the County are noted on figure 2 and described. It can be said that Area 3 is the recharge area for the relatively good water-table aquifer of the sandhill area. Area 4 shows, in part, discharge areas. Area 5 is a rather low plain in the elbow of the Northeast Cape Fear River. Although a shallow water-table aquifer and an underlying artesian aquifer in the Peedee Formation exists, the aquifers are not highly permeable. The sand artesian aquifer is lower in the Peedee Formation than the Sandstone aquifer of Areas 1 and 2. Recharge to Area 5 is of less importance than that to Areas 1 and 2. Area 6 is a nondescript area that can

be subdivided locally; in addition to the prevailing shallow sand water-table aquifer, either the underlying Castle Hayne or Peedee Aquifers is available as a source of water. Neither the Castle Hayne nor the Peedee is sensitive to recharge conditions in Area 6.

General Thoughts Useful in Zoning Plans

It is not a purpose of this project to delve into either specific zoning problems or complete zoning criteria. Yet, some helpful considerations come from the study.

By applying the principle of exclusion, it is shown that some areas are unfavorable for sanitary landfills or waste lagoons containing toxic substances for some of the following reasons:

1. Water-table aquifers locally sensitive to contamination (most of Areas 2 and 3)
2. Artesian aquifer recharge areas less sensitive to contamination (Area 1)
3. Areas where risk of surface-water contamination is great - (zones of Area 4 within about 1000 feet of rivers)

It is not implied that remaining areas of the County are favorable or suitable for landfills or waste lagoons. We must start with the following counterpoints that apply to every county in North Carolina: (1) there is no ideal site, but (2) one or more landfill sites must be selected - perhaps tolerated - in the least unacceptable place. New Hanover County has areas where landfills can be managed and tolerated.

Zoning that focuses on acceptability of septic tanks is a consideration for all counties. There are several complex ground-water factors that control wastes from septic tanks, but for our purpose these can be cast in simpler terms of distance from a septic tank to a well or other water source. Thus, the space factor, generally in terms of size of lots, is vital.

Suitability for septic tanks must be considered first from counterpoints relating chiefly to permeability. Surface materials of low permeability are not likely to be suitable because they result in poor percolation and are subject to nuisance and to hazards of effluent at the land surface. On the other hand, permeable soils allow easy infiltration and lead to the risk of contaminating the ground water. Low permeability may result in a water-table near land surface. The relatively high water table in much of New Hanover County is due chiefly to the low and level topography and less to poor permeability. At any rate, areas of poor suitability for septic tanks are shown in detail on the maps of the Soil Survey and New Hanover County, prepared in April, 1977, by the U.S. Department of Agriculture.

The various aquifers of the County show a wide range in sensitivity to contamination of septic tank systems. The water-table aquifers of Areas 2 and 3 are highly permeable or moderately permeable in most places and can be contaminated locally if wells and septic tanks are closely spaced. The shallow water-table in Area 1 can be prone to contamination locally where wells and septic tanks are closely spaced. Yet, the principal aquifer (Castle Hayne and Peedee) below is insulated from contamination by septic tank effluent.

Where wells and septic tank systems are interspersed in the same shallow water-table aquifer at close intervals - perhaps half-acre lots - there generally tends to be some contamination of the ground water. Thus, many counties consider zoning requirements of acre lots under these conditions. Yet, if a good aquifer is available for alternate use under the water-table aquifer or if central water or sewer system is planned for the particular area, the smaller lot size - somewhat less than one acre - may be best in the long run.

Protecting primary recharge areas is the proper starting position for consideration of zoning that relates to the subsurface environment. But what about the other end of the spectrum and intermediate positions of ground-water protection? Unfortunately, regulatory agencies, including the U.S. Environmental Protection Agency, have not adequately considered all of the ground water in a balanced way. There must be some elements of tolerance and acceptance of some contaminated ground water. In a sense, there must be negative zoning in restricted areas. Two examples of negative zoning in New Hanover County come to mind. First, the area under Flemington Landfill and extending down gradient beyond the contaminated ground-water plume for a few tens of acres should be restricted from ground-water use. Second, the near-surface water-table aquifer under the most urbanized part of Wilmington might properly have some restrictions for water supply because of leaky sewers and the numerous unrecorded spills and leaks that are characteristic of urban areas everywhere.

The preparation of this preliminary report (map, document, etc.) was financed in part through a grant provided by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration.

Harry E. LeGrand

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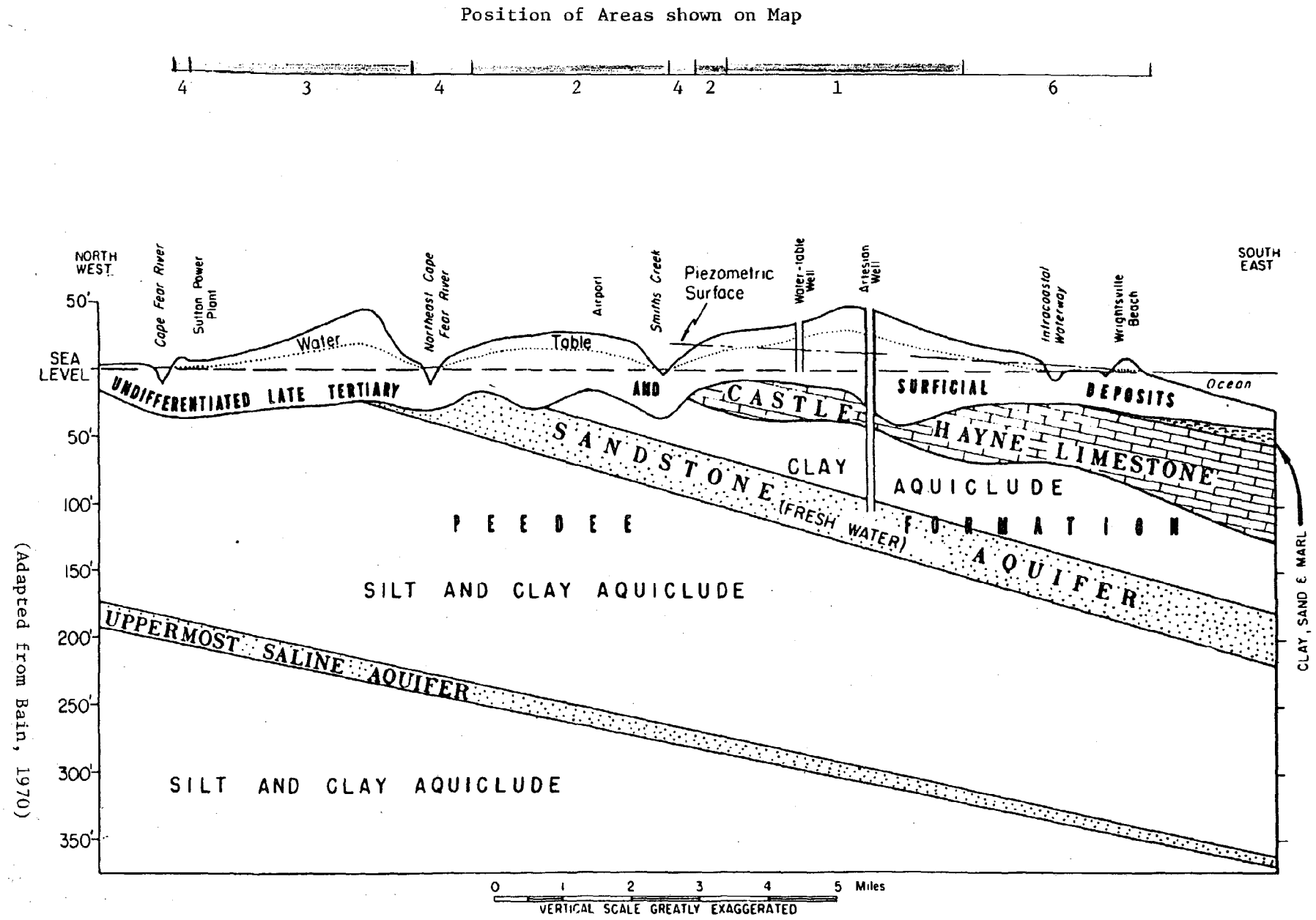
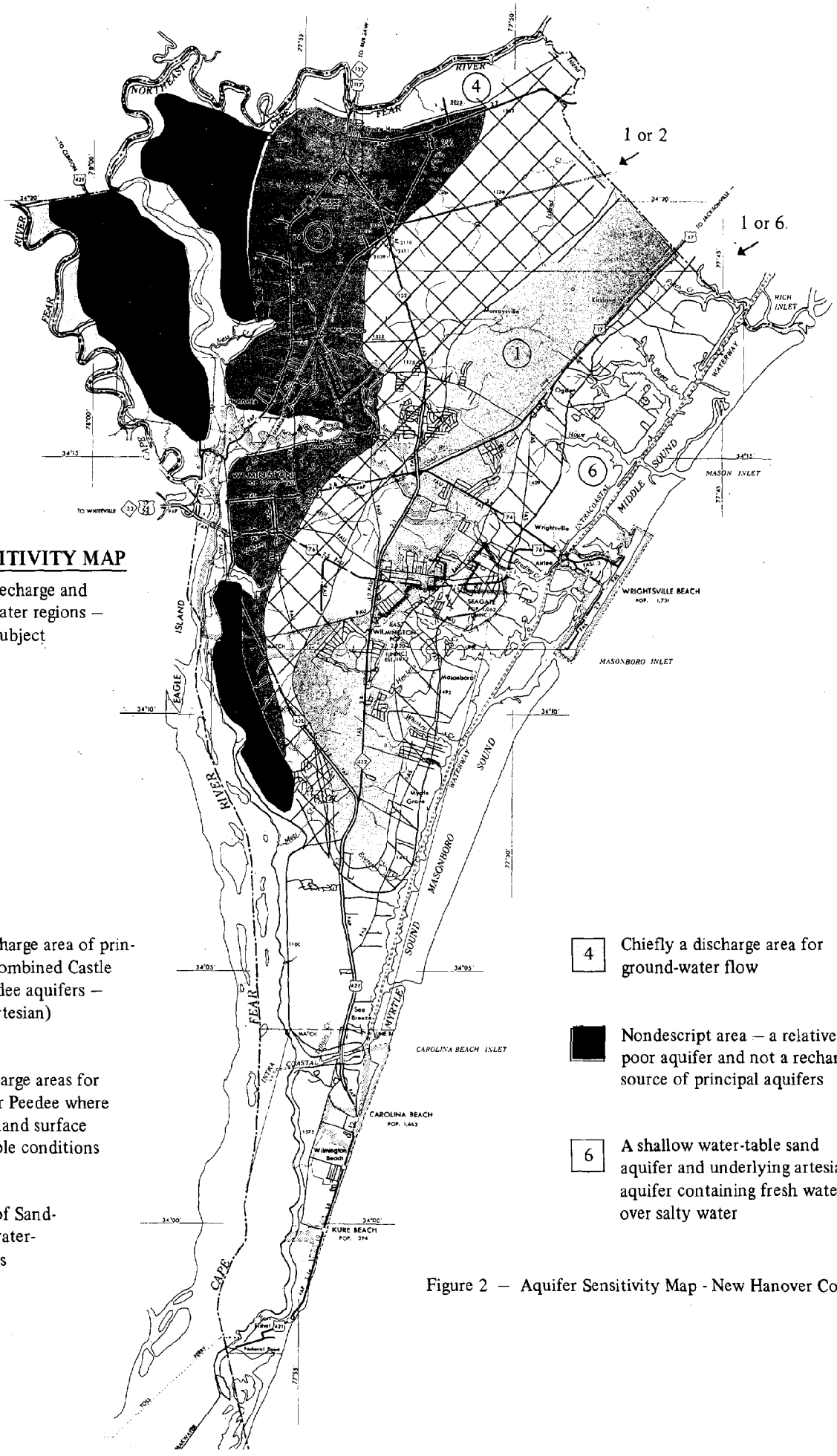
Independent Hydrogeologist

January 27, 1982



(Adapted from Bain, 1970)

Figure 1 --Generalized diagram showing the relation of geologic conditions to the occurrence of fresh ground water.



AQUIFER SENSITIVITY MAP

General aquifer recharge and related ground-water regions – (boundaries are subject to revision)

- Preliminary recharge area of principal aquifer (combined Castle Hayne and Peedee aquifers – confined and artesian)
- Secondary recharge areas for Castle Hayne or Peedee where occurring near land surface under water-table conditions
- Recharge area of Sandhill aquifer – water-table conditions
- 4 — Chiefly a discharge area for ground-water flow
- Nondescript area – a relatively poor aquifer and not a recharge source of principal aquifers
- 6 — A shallow water-table sand aquifer and underlying artesian aquifer containing fresh water over salty water

Figure 2 – Aquifer Sensitivity Map - New Hanover County

NEW HANOVER AQUIFER RECHARGE PROJECT: ANALYSIS OF REGULATORY ALTERNATIVES

The purpose of this report is to analyze regulatory alternatives for protecting New Hanover County's significant aquifer recharge areas.

This report constitutes the second phase of an aquifer recharge project funded by the North Carolina Department of Natural Resources and Community Development. The first phase consisted of the delineation of aquifer recharge boundaries and recommended standards for future development. That phase was completed by Raleigh consulting hydrogeologist Harry E. LeGrand.

This report consists of two parts. The first part draws upon the technical information presented by LeGrand to summarize aspects, functions and characteristics of the recharge area that will require protection, while the second part provides regulatory alternatives based upon these needs.

The results of this report will be used to complete that third and final phase of the aquifer project: a comprehensive ordinance to protect the County's significant aquifer recharge area.

I. AQUIFER FUNCTIONS AND CHARACTERISTICS REQUIRING PROTECTION.

LeGrand's Aquifer Recharge Boundary Study has identified primary and secondary aquifer recharge areas in New Hanover County; the boundaries of these areas are shown on the attached map, and are separately discussed below.

A. Primary Recharge Area. The greater percentage of recharge to the combined Castle Hayne-Peedee aquifers occurs through the primary aquifer recharge area. It functions as follows:

> The primary recharge area...represents indirect recharge because water from precipitation passes downward through the water-table aquifer and the upper clay or fine sand bed before reaching the composite Castle Hayne-Peedee aquifers. In this case, the indirect recharge is a blessing because it makes the aquifer less sensitive to surface contamination than if the aquifers were exposed at the land surface... (LeGrand, p. 3).

1. Density of Development. Although the shallow water table in the primary recharge area might be contaminated by closely spaced wells and septic tanks, the principal Castle Hayne and Peedee aquifer is insulated from contamination by septic tank effluent (LeGrand, p. 8). Generally, "normal suburban expansion and small businesses with no significant waste problems probably should not lead to an aquifer contamination problem." (LeGrand, p. 5)

2. Quantity of Recharge. The anticipated effects of land development on the quantity of recharge to this aquifer are stated as follows:

> With the very small pumping from this aquifer now, only a part of potential recharge reaches the principal aquifer; much of the potential recharge is not needed and, therefore, shunted out to discharge in the shallow sand water-table system. If heavy pumping of the principal aquifer were to start and continue for perhaps 30 years, there might be some movement of contaminants downward to this aquifer from the land surface. This is only a possibility, and if it were to happen, the problem could be detected early before serious damage is done. (LeGrand p. 5).

If very large tracts were developed with equivalent areas of impervious surfaces, there would be some impact on recharge. However, a well-monitoring program could detect problems 2-3 years in advance. (Conversation with LeGrand, 1/6/82).

3. Land Use Constraints. Although typical suburban development will not threaten the primary recharge area, "sanitary landfills and industries having significant handling of toxic materials" should be excluded. (LeGrand, p. 5).

B. Secondary Recharge Area. The characteristics of the secondary recharge area are as follows:

> (In this area) the principal aquifer is near land surface and mostly under water-table conditions. Recharge is more direct than in Area 1, and the potential for contamination is greater. The overall potential for ground-water extraction is somewhat less than in (the primary recharge area), chiefly because the aquifer is relatively thin (in most places only the Castle Hayne or Peedee aquifer is present. (LeGrand, p 6).

1. Density of Development. The water table aquifers of this area are highly or moderately permeable in most places and can be contaminated locally if wells and septic tanks are closely spaced. (LeGrand, p. 8).

> Where wells and septic tank systems are interspersed in the same shallow water table aquifer at close intervals-perhaps half-acre lots-there generally tends to be some contamination of the ground water...Yet, if a good aquifer is available for alternate use under the water-table aquifer or if central water and sewer system is planned for the particular area, the smaller lot size-somewhat less than one acre-may be best in the long run. (LeGrand, p. 8).

2. Quantity of Recharge. This issue was not specifically addressed in the secondary aquifer recharge area. When compared to the primary recharge area, the potential for groundwater development is "somewhat less"; however, some limitations on excessive drainage may be appropriate.

3. Land Use Constraints. A prohibition of landfills and industries handling toxic materials is particularly critical in this area. (See LeGrand, p. 7). Further, if the aquifers underlying the primary recharge area are drawn low through intensive well pumping, contaminated waters in the secondary area could spread to the primary area.

Consideration should be given to areas where the water yielding capacity of the aquifer is fairly high but where contamination has not yet reached a serious problem; the portion of the secondary recharge area north of Smith Creek is such an example that needs protective measures because it is a sensitive area for contamination (LeGrand, p. 6).

C. Sandhill Water - Table Aquifer. The recharge area for the relatively good water-table aquifer of the sandhill region (south of Wilmington near the Cape Fear River) is shown as Area 3 on the attached map.

Generally, the comments discussed under the Secondary Recharge area above also apply to this area.

D. Recognition of Contaminated Ground Water. The comments in A-C above all relate to protecting primary recharge areas. However, LeGrand has also discussed regulatory responses at the other end of the spectrum: protection against consumption of contaminated ground water.

> In a sense, there must be negative zoning in restricted areas. Two examples of negative zoning in New Hanover County come to mind. First, the area under Flemington Landfill and extending down gradient beyond the contaminated ground-water plume for a few tens of acres should be restricted from ground-water use. Second, the near-surface water-table aquifer under the most urbanized part of Wilmington might properly have some restrictions for water supply...(LeGrand, p. 9).

II. REGULATORY ALTERNATIVES

This section of the report considers and evaluates various regulatory alternatives, given the aquifer characteristics as disclosed in Section I above. The proposed comprehensive aquifer protection ordinance will be drawn from these alternatives, and will consist of those regulations which achieve the greatest amount of protection needed for the aquifer while minimizing their impact on the private land market.

Given this approach, the two most restrictive regulatory options - public land aquisition and the prohibition on most forms of development - can be rejected at the outset. These responses would be overbroad; they would preclude private uses of the property that could be entirely consistent with the natural functions of the aquifers as detailed by LeGrand.

Other options less severe are available. The following six regulatory alternatives are analyzed below: administrative assistance; targeting of public expenditures; drainage performance standards; zoning for density limits; zoning for land uses; "negative zoning".

A. Administrative Assistance. Given the technical study prepared by LeGrand, the Planning staff can now plat the boundaries of the primary and secondary aquifer recharge areas on its planning maps. These maps can be used during the review of all case-by-case planning decisions (e. g. special use permits, zoning, subdivisions.)

In these cases, the staff can incorporate aquifer protective measures into its recommendations.

Additionally, the recently-defined boundaries can be communicated to land developers in pre-application conferences, enabling the developers an opportunity to revise their plans in accordance with the requirements of the recharge area.

Obviously, the administrative assistance option is by itself an insufficient protective measure. It fails to address the density and character of those land uses which are permitted by right in the respective recharge areas. However, it can form a useful portion of a more comprehensive scheme.

B. Targeting of Public Expenditures. The timing and location of capital improvements often exerts a greater force on the environment than regulatory measures. In New Hanover County, spending decisions in three categories could significantly impact the recharge areas. The categories are: water and sewer projects, solid waste, and drainage.

1. Water and Sewer. A complete plan for water and sewer construction is presented in New Hanover County' latest Capital Improvements Program. This water and sewer plan has been repeatedly endorsed by the Board of Commissioners; funding constraints aside, substantial changes in the service areas are unlikely. Consequently, the comments here are based on the water-sewer plan in its present form. To the extent that substantial changes in the water-sewer plan are made in the future, the aquifer protection strategies recommended here will have to be modified accordingly.

Much of the primary and secondary recharge lands will be served by public water and sewer by 1990. Exceptions are a portion of the primary area south of Monkey Junction, and portions of the primary and secondary areas north of the County Airport. For those recharge areas served by water and sewer, medium development densities can be allowed.

However, unserved areas (particularly the secondary recharge area north of the airport) will require protection through density limitations. Otherwise, closely-spaced well and septic systems will contaminate the water-table.

One proposal for the County's water system is heavily dependent on groundwater. Substantial pumping of the underground aquifers can be expected if the plan is carried out. Consequently, an annual appropriation for well-monitoring should be budgeted as part of the water-sewer program. The well-monitoring would be used to provide warning signals concerning substantial changes in the aquifers as pumping continues.

2. Solid Waste. New Hanover County has established a permanent plastic-lined landfill in a relatively safe area of the County. A recently passed bond issue for incineration facilities will prolong the life of this landfill to about 60 years. These investment decisions are consistent with aquifer requirements. Again, substantial changes may require correlative changes in the aquifer regulations.

3. Drainage. Although no County drainage improvements are included in the 10-year Capital Improvements Program, the County Commissioners have discussed this topic on several occasions. If the County does choose to become involved in drainage in the future, it is essential that the drainage program be coordinated with the aquifer requirements as defined in this report.

C. Drainage Performance Standards. Quite apart from any investment decisions the County could make regarding drainage, regulations could be enacted to insure that the quantity of recharge to the various aquifers is not reduced. A typical regulatory response is the requirement that all new developments discharge no greater runoff than the site discharged in its previous natural state.

Prior to the commencement of this project, staff anticipated that this type of performance standard might be an important component of the management plan. However, LeGrand's findings indicate that quantity of recharge is currently not a significant problem in New Hanover County. He recommended a constant well-monitoring program to detect early signs of groundwater deplenishment.

Although adoption of regulations governing runoff limitations may not be required at this time, it is recommended that the staff commence preliminary work in the development of appropriate standards for future use.

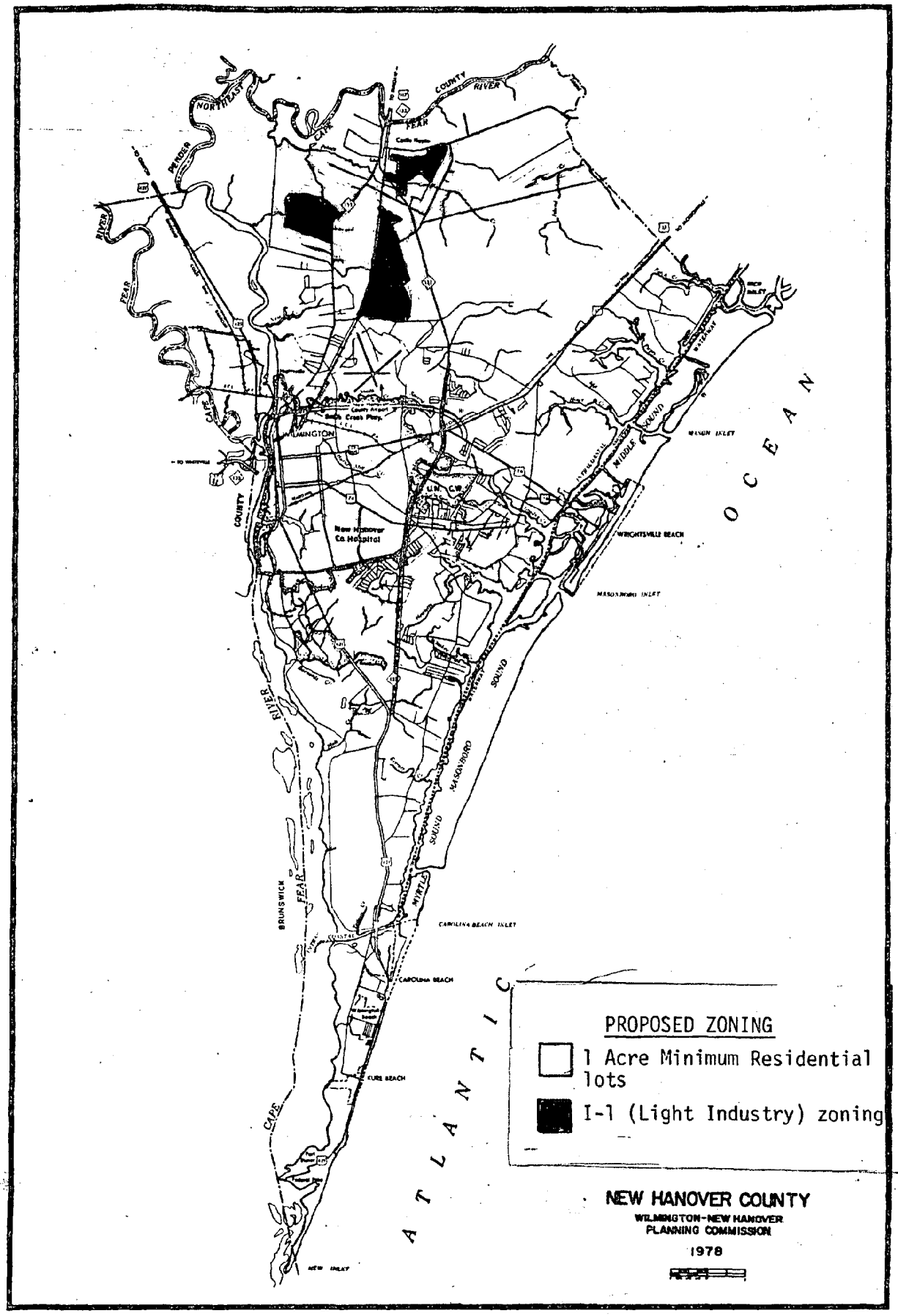
D. Zoning for Density Limits. The portion of the secondary recharge area which lies north of the airport will not be served by the Countywide water and sewer system. Since this area is particularly sensitive to contamination, it is recommended that all residentially zoned land in this region be reclassified so as to require one acre minimum lot sizes. This measure will achieve the separation between wells and septic tanks that is needed to prevent contamination of the water-table aquifer. Areas to be rezoned for one-acre minimum lots are indicated in yellow on the attached zoning map.

E. Zoning for Land Uses. Landfills and industries handling toxic materials should be excluded from both recharge areas. Exclusion from the secondary recharge area is particularly critical, given that area's susceptibility to contamination. The County's I-2 Industrial Zoning category permits such threatening land uses. Consequently, all lands in the secondary recharge area which are presently zoned I-2 should be rezoned to less intensive I-1 or AI light industry categories. Lands requiring this industrial rezoning are indicated in purple on the attached zoning map. Original zoning when established in the unzoned area of Castle Hayne should also reflect these limitations on density and land use.

F. Negative Zoning. The term "negative zoning," as used by LeGrand, involves the prohibition of ground-water use in previously contaminated areas. (e.g. under Flemington landfill, under the most urbanized part of Wilmington).

In these areas, water should be supplied exclusively through public systems which obtain water from other areas of the County.

The preparation of this report was financed in part through a grant provided by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration.



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FEAR
COUNTY
RIVER
WILMINGTON
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MIDDLE SOUND
WRIGHTSVILLE BEACH
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