

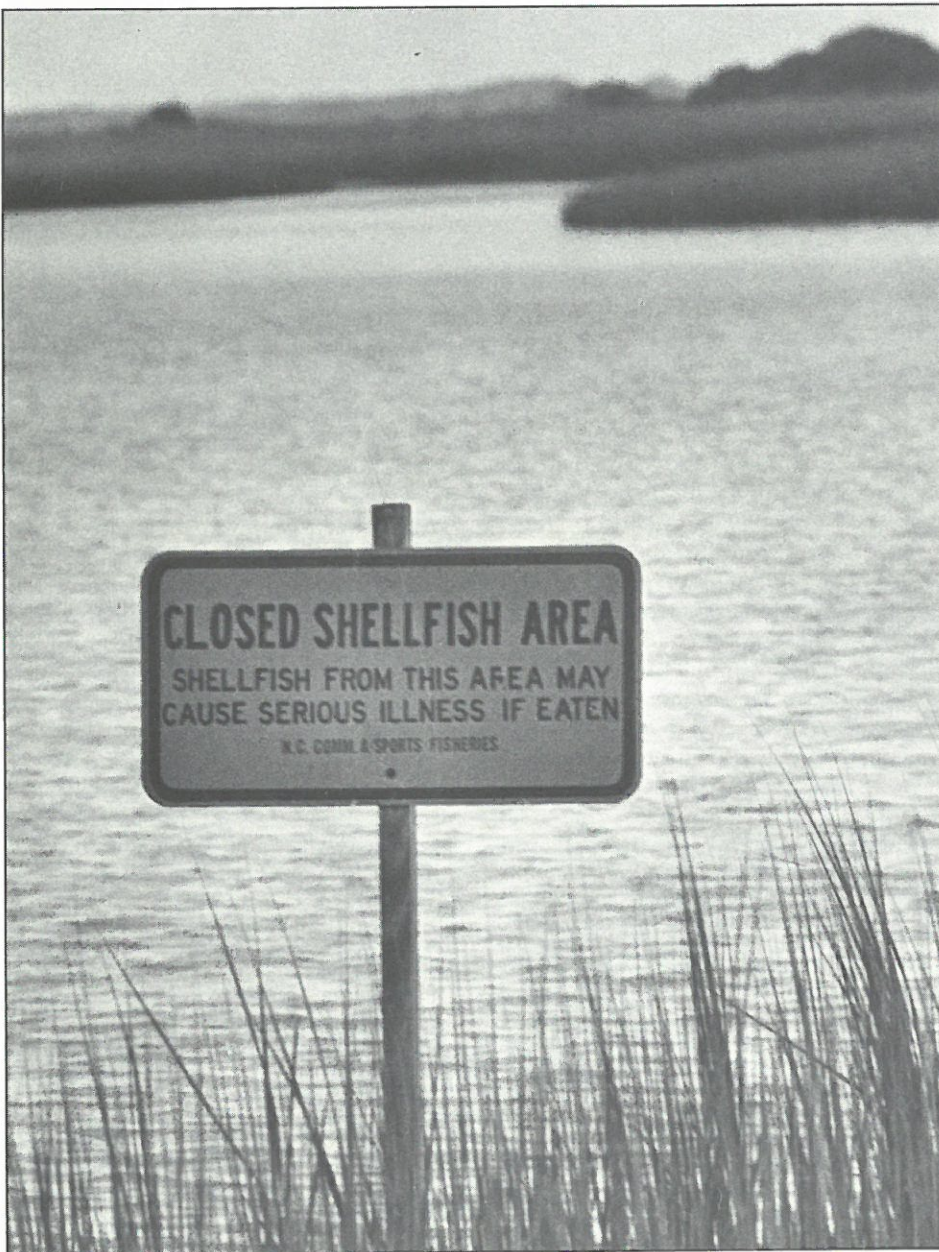
# COAST WATCH

UNC Sea Grant College Program

Vol. 6, No.4

April, 1979

## Septic tanks - a lesson in designing with nature



*Septic tank pollution—how much of a threat?*

The rain had finally stopped. As David Spencer walked around the puddles in his yard the grass beneath his feet squished like a wet sponge. Down the road his neighbor's property looked the same—water-logged.

"All the land around here has clay in it," Spencer explained. He pointed to his backyard, "You could dig a hole there and put water into it and the water will just sit there until the sun dries it up."

Four years ago when Spencer bought the land in coastal Hyde County he didn't think much about the clay in the soil or the fact that the water table lies less than two feet below the surface. At the time the local sanitarian had assured him that there would be no problem in using a septic system on his land.

But last year when Spencer applied for a building permit he discovered that everything had changed. Under new state disposal regulations he could not use a conventional septic system because his land did not have the proper permeability or adequate separation from the water table. With Germantown Bay only 175 feet from the site, the county sanitarian had little choice but to turn the application down. Unless Spencer could install an alternative system, he would not be allowed to develop the property.

Spencer's story is not unusual. More and more property owners in coastal North Carolina are discovering that poor soil conditions and high water tables make safe disposal of septic wastes a major issue. Though the source of the problem varies from location to location—ranging from coast



sands, high water tables, muck soils and clayey subsoils—the result is the same. New development is stunted, while older, more established areas experience the growing aggravation and expense of failing septic systems.

### Search for alternatives

For more than three years UNC Sea Grant researcher Bobby Carlile of North Carolina State University has been studying on-site septic waste disposal in the coastal zone. According to Carlile the disposal dilemma of coastal North Carolina typifies that facing many other rural coastal states. He compares it to the proverbial rock and a hard place. On the one hand, in many areas the state's coastal population is too sparse and seasonal to support centralized sewage collection and treatment. On the other hand, unsuitable soils and high water tables often make it difficult to find sites where conventional on-site disposal systems will work.

But effective, low cost alternatives to sewers and septic tanks are available. Researchers have found that the basic septic system design can be modified and improved so that it will work under a variety of conditions. With Sea Grant support, Carlile has been experimenting with these alternative systems and modifying them for use in coastal environments.

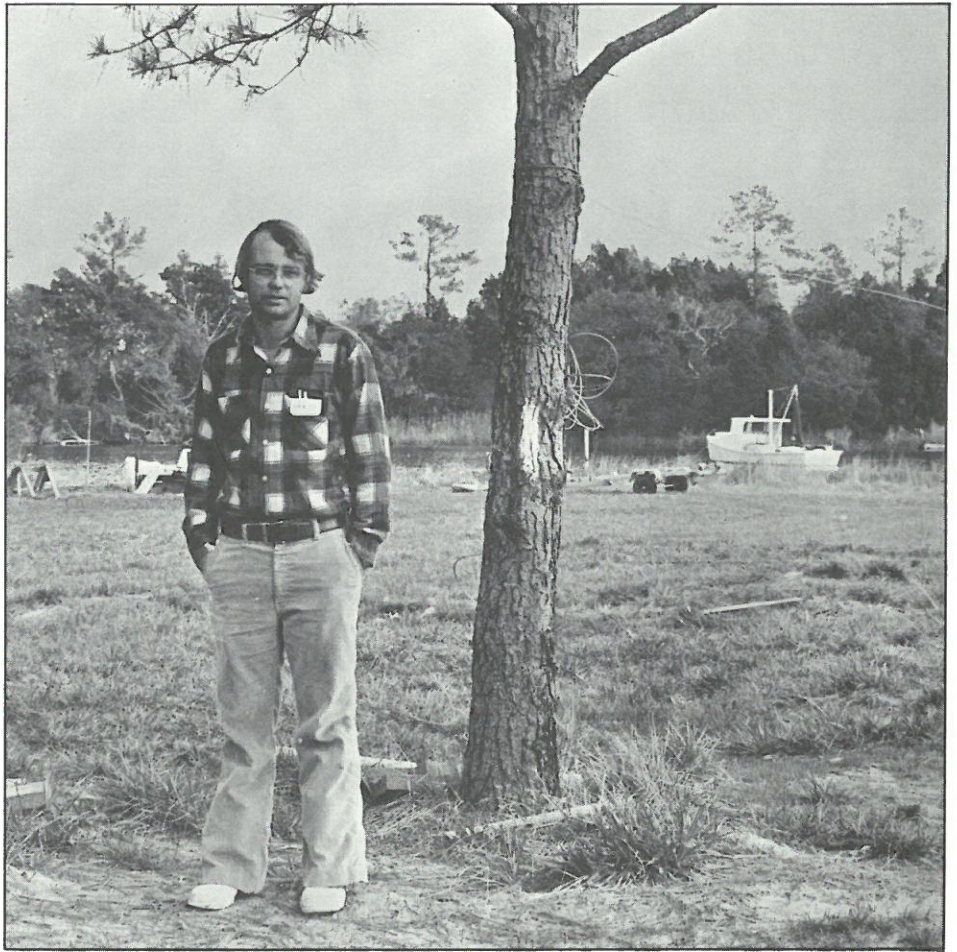
### Critical timing

Along the coast his research has borne fruit at a critical time. Two years ago new regulations were issued putting more "teeth" in the state's Ground Absorption Act. Soil permeability criteria were defined and setback and separation standards were established. The result—septic waste disposal became an explosive issue throughout the coastal zone. In Hyde County alone more than 50 percent of the applications for septic tank permits were rejected over a 14-month period.

"We were almost at a standstill," recalls Clifford Swindell, Hyde County manager. "Our contractors were complaining. The people who lend money were complaining. And the people who wanted to develop their lands were complaining . . . Under the new regulations we just couldn't fit in."

"We were fast reaching the crisis stage," adds County Commissioner Eddie O'Neal.

For Carlile the conditions in Hyde



*Spencer: clay soils, high water tables and building headaches*

County provided an ideal testing ground for many of his modified systems. Several experimental systems already had been installed in Hyde County and elsewhere. And, after a series of meetings with officials from the state Department of Natural Resources and Community Development and the Department of Human Resources, the county Board of Health was given the go-ahead to use Carlile's systems wherever conventional ones wouldn't work.

Though skeptical at first, David Spencer knew that a modified system was the only option he had if he wanted to build on his land. Following the lead of his neighbor, Meredith Cook, Spencer agreed to have Carlile install a low pressure distribution system on his property.

At both Cook's and Spencer's sites local contractors, developers and health department officials were invited to watch the installation process and learn more about the system's operation. Monitoring wells were constructed at the sites so that the researchers could keep tabs on ground

water quality in areas adjacent to the systems.

After nearly two years Meredith Cook is convinced that Carlile's low pressure system is the only disposal technique that will work on his property. "It's used the heaviest in December and January, which are also the wettest months, and I've never had any problems," he says.

Though Spencer's system is only six months old, he too is pleased with its performance. "It's probably the best system around here. To use a conventional system I would have had to dig up most of my yard and it would have cost a lot more."

### The bail out

Today the septic tank issue has quieted in Hyde County. Local health officials credit much of the improvement to Carlile and his modified systems. Last year 13 sites that would have been rejected under conventional septic treatment were approved for low pressure distribution systems. "You might say the systems bailed us out," says Swindell.

"People now are more aware of the restraints on where they can build," adds O'Neal. "They don't just go out and buy a piece of land and then worry about getting a permit for a septic tank."

Throughout North Carolina the news of Carlile's work is spreading fast. In the last three years more than 100 low pressure distribution and 10 mound systems have been installed under his supervision in 11 coastal counties. Dozens more have been installed by contractors and individual homeowners who have found out about the systems at workshops led by Carlile.

"We've been able to use so-called marginal lands that otherwise we'd have no choice but to turn down," observes Craven County Sanitarian Al Harris. "The alternative systems allow us to have economic growth and yet we're still protecting the environment."

### The density threat

In recent months Carlile has focused his attention on the southern section of the coast where dense populations pose the most serious problem.

"We're projected to be a major growth area in North Carolina," explains New Hanover County Sanitarian Frank Olive. "More growth means more homes and more homes mean more septic tanks and increased potential for pollution. You get the domino effect."

Although the city of Wilmington has a centralized sewage system, outlying unincorporated areas in New Hanover and Brunswick Counties currently rely on on-site disposal methods. As in many coastal areas, sites suitable for conventional septic systems are few and far between.

"Most of our lots are requiring some sort of modification," says Olive. Typically this involves such remedial measures as drainage, back filling and modified trenching. But on some sites this isn't enough. It is in these areas that Olive thinks Carlile's work could have the greatest impact.

So far two low pressure and one mound system have been installed in the county. While it is still too early to tell if the systems will work there, Carlile, Olive and many local contractors and developers are keeping a watchful eye on their performance.

Despite the success of his work in coastal North Carolina, Carlile is the

first to emphasize that the systems are not a panacea to septic waste disposal problems in all rural areas. "Some people get the idea that with alternative systems you can build in the marsh," he jokes. "The fact is that we're still looking at sites that are unsuitable and can't be developed."

### Maintenance needs

One of Carlile's chief concerns is the fact that modified systems require more maintenance than conventional ones. "The old conventional system,

when it's working right, is the most maintenance-free system available," he says.

With modified systems pumps must be inspected regularly, distribution lines checked and tanks pumped out before they fill with solids. "A homeowner has to be aware of what the system is, how it works and what routine maintenance is required," he stresses. How well an alternative system works, Carlile warns, ultimately depends on how mindful a property owner is of routine maintenance needs.

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## New twists to an old design

There's nothing new about the septic tank. In fact it's one of the oldest systems of waste treatment. It was first introduced to this country nearly a century ago and, for the most part, has remained relatively unchanged. Today in North Carolina there are more than two million septic tanks in operation with an estimated 50,000 more being added yearly. Nationally, 85 percent of the individual, on-site waste disposal systems rely on septic tanks and cesspools.

In a nutshell, the septic system takes advantage of the soil's natural filtering properties. Wastes are channeled from the house into a holding tank where solid portions settle out at the bottom of the tank as sludge. Although anaerobic bacteria in the tank digest or breakdown much of the sludge, residual solids accumulate and, from time to time, must be pumped out and disposed of—either at a treatment plant or land application site.

The liquid portion of the waste or effluent flows out of the tank and travels along a series of pipes into a specially designed absorption field. In the absorption field the effluent slowly seeps through the soil. The soil acts like a huge filter, trapping solids and absorbing dissolved contaminants in the effluent. These trapped materials, in turn, are nourishment for tiny organisms growing in the soil. By the time the effluent has traveled through the various soil layers and reaches ground water it has been thoroughly treated.

At least in theory that's how a septic system operates. But not all soils act the same way in filtering effluents. Sandy soils, for example, have such large pore spaces between the soil particles that the effluent may rush through the absorption field without being filtered.

By contrast, tight soils with high clay content can be so dense that they are impermeable. The result—untreated wastewater collects or ponds on top of the impermeable layer and can surface.



*When theory breaks down*



According to Soils Extension Specialist Bobby Carlile of North Carolina State University these poor soil conditions are not restricted to a single geographic area. They can be found just about anywhere. Along the coast these conditions are confounded by the presence of high water tables. And from Carlile's perspective, that's where the real headaches begin for waste disposal.

### Confounding the issue

"When you try to put sewage in ground with a high water table, it's just like trying to put water into a jug that's already full," he explains. "You don't get the degree of treatment that you have in aerated soils."

Carlile estimates that in many areas of coastal North Carolina nearly 90 percent of the soils are unsuitable for conventional septic systems. Nationally, the United States Environmental Protection Agency estimates that as much as one-half of the soils are unsuitable. Faced with those grim statistics, property owners in the past have had little choice but to invest in expensive chemical treatment units or drainage systems or simply sell their land. But Carlile believes that this isn't always necessary. In many instances the homeowner or developer can install a modified septic system that will work where a conventional one won't, and at only a slightly higher cost. The key he says, "is to make the system fit the site."

And that's exactly what Carlile has

been doing over the past three years with UNC Sea Grant. To date his two most successful designs involve a low pressure distribution system and a mound system.

### The low pressure system

The low pressure distribution system utilizes the natural soils at the site. In theory it is nearly identical to the conventional septic system except that a low pressure pump enables the effluent to be distributed more efficiently and uniformly over the entire soil absorption area. Distribution is accomplished by pumping the effluent under low pressure through a network of small diameter, perforated PVC (plastic) pipe. In addition, the pumping station doses or limits the amount of effluent entering the field at a given time. The combined effects of better distribution and dosing help prevent the soil in the absorption field from becoming clogged and saturated. Because the soil is then able to "dry out" and re-aerate between doses, the level of effluent treatment is improved.

In the conventional system, the force of gravity moves the effluent through the system and the overall orientation of the system must be downhill. Unfortunately, in low-lying areas typical of the coastal plain, such sites are rare or often located dangerously near sources of ground and surface water. With the low pressure distribution method a pump rather than gravity is used to move wastewater through the system. Dis-

tribution lines do not have to be placed as deeply in the ground, and, if necessary, the effluent can be pumped upward, away from water tables and into better soils.

Carlile estimates the cost of the typical low pressure system at between \$1,200 and \$1,500, about 25 percent more than a conventional septic system. But it requires virtually the same amount of land as a conventional absorption field.

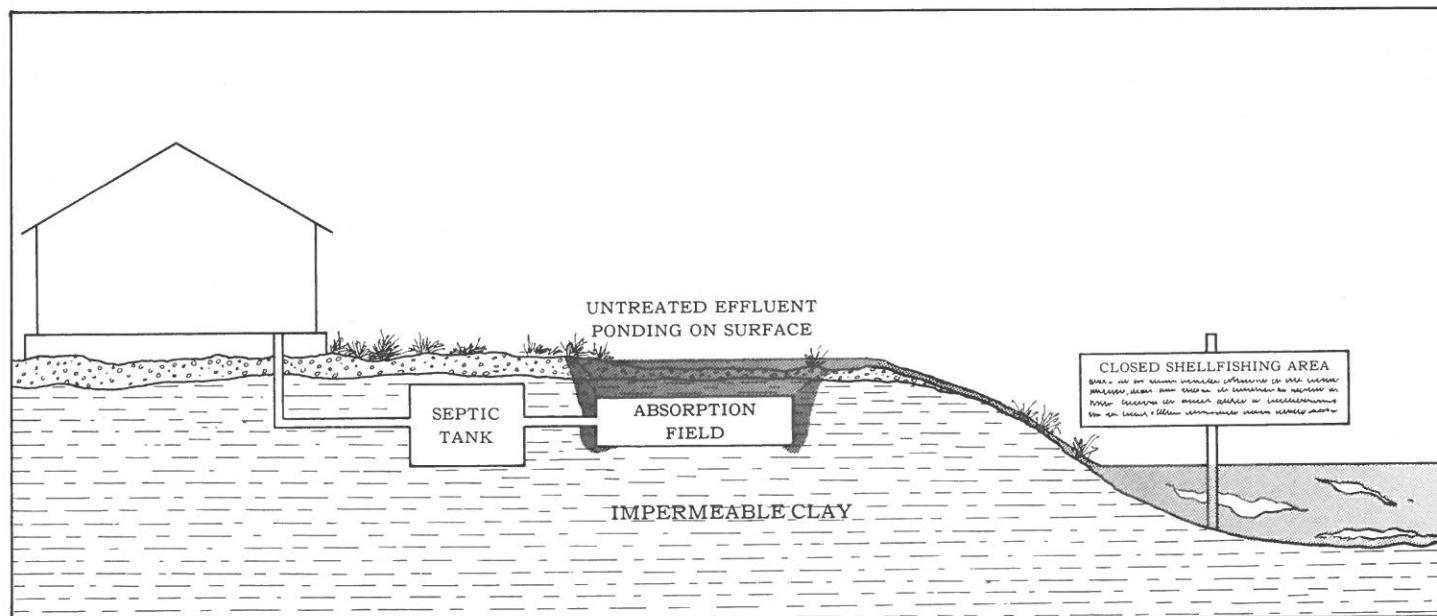
### The mound system

The mound system is another modified system that Carlile has worked with. Because an essentially "artificial" system must be built, he considers the mound technique "a last resort" for areas where natural site and soil conditions are extremely poor.

In this system the absorption field is constructed above ground in a soil mound. The mound itself is a layered hill of loamy fill, gravel and sand which effectively treats the wastewater before it reaches the natural soil surface. A low pressure system is placed inside the mound to ensure that the effluent is evenly distributed.

The one drawback to the mound system is its cost—nearly double that of the low-pressure system, depending on how far the fill material must be transported. Despite the high price tag, Carlile believes it is one of the least costly alternatives for property owners faced with particularly troublesome sites.

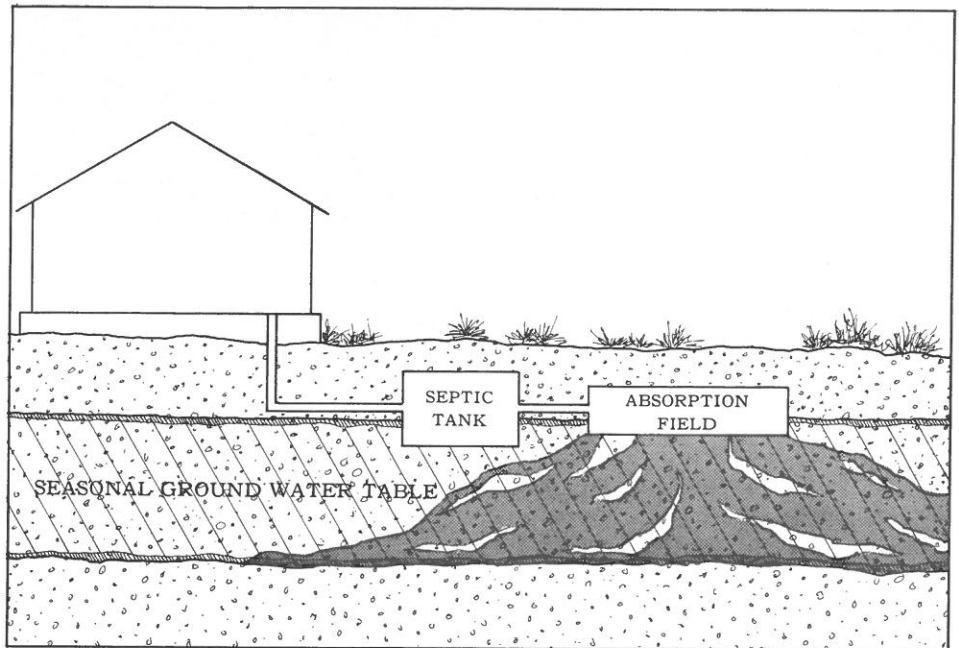
While the alternative systems are



still considered experimental, regulations issued under the state's Ground Absorption Act now recognize the right of property owners and developers to use these systems on problem sites as long as they can be proved effective. Similar regulations are in effect in other states.

### State of the art

For Carlile these rulings have been an important boost to his work. According to Steve Steinbeck with the North Carolina Department of Human Resources' Division of Health Services, they open the way for more and more breakthroughs in the area of alternative on-site waste disposal. "Systems such as low pressure distribution are fast becoming the state of the art instead of experimental," he says.



## Studies probe the basics of septic waste disposal

Beyond the issue of disposal system design and maintenance there are still many questions that need to be answered about on-site waste disposal in general. In addition to the Sea Grant project, several other studies are being conducted in North Carolina. A special state task force has been formed to address the issue of alternative sewage disposal.

One important area of research concerns the effectiveness of alternative systems in filtering contaminants. As part of the Sea Grant study, microbiologist Mark Sobsey of the University of North Carolina at Chapel Hill is studying the effectiveness of the low pressure and mound systems in removing bacteria and viruses in wastewater. Viruses are particularly difficult to filter out because they are so small and can rapidly migrate through pores in the soil. At several study sites, Sobsey is assaying waters from special observation wells and surface waters adjacent to the alternative systems.

In addition, a network of 168 monitoring wells has been set up along the coast in 11 counties to determine the extent of water table fluctuations both tidally and seasonally. This information is important for designing the disposal systems and in refining septic tank regulations.

One of the biggest concerns along the coast has been the impact of pollution from poorly treated wastewater on shellfishing waters. Last year more than 400,000 acres of clam and oyster waters were closed to harvesting in North Carolina. While Bob Benton of the state's Shellfish Sanitation Division believes that "septic tanks play a significant role in the closure of these areas," he is unable to quantify "significant."

### Bridging the gap

"There are so many other factors," emphasizes Charlie Jackson with the Shellfish Division, "that we can't make a blanket statement." Runoff from industry, farming operations and even the natural decay of plant and animal material contribute to the closure of shellfishing waters.

According to Steve Steinbeck with the Division of Health Services the connection between septic tank pollution and shellfish contamination has never been clearly demonstrated. "There's been a lot of innuendo, but the data is not conclusive. We'd like to have some good hard evidence," he explains.

In an effort to answer some of the more basic questions about wastewater contamination, the Coastal Plains Regional Commission recently awarded

an \$80,000 research grant to the North Carolina Department of Human Resources' Division of Health Services. According to Steinbeck, who is the project director, the focus of the research will be on determining the fate of contaminants and nutrients typically found in wastewater as they move through the soil. Both Carlile and Sobsey are participating in the study.

The research project will involve detailed monitoring of conventional and modified septic systems in Hyde, Craven and New Hanover counties. These counties, Steinbeck explains, were selected because they represent a range of soil problems, "from very well drained soils to muck soils, from organic soils to hard pans."

Steinbeck believes that the results of the study will be important in shaping future septic disposal regulations and in providing researchers with an opportunity to quantify the role of soil and ground water characteristics in wastewater treatment.

### Beyond the coast

The problem of on-site waste disposal isn't limited to coastal North Carolina. Problem soils and high water tables extend across state borders and beyond the coastal plain into Piedmont and mountain regions.



In central North Carolina, the Triangle J Council of Governments is sponsoring a comprehensive study on improved wastewater disposal. The Triangle J region includes six Piedmont counties—Chatham, Durham, Johnston, Lee, Orange and Wake—covering a broad spectrum of problem soils and conditions. The one-year study is being funded under a water quality management grant from the United States Environmental Protection Agency (EPA) under Section 208 of the Federal Water Pollution Control Act.

David Reynolds, project director with Triangle J, describes the study as a combination of research, demonstration and public education. It is unique, he adds, because it focuses on both the technological and regulatory aspects of wastewater disposal.

### Dual approach

In one part of the study researchers with the Institute of Government at the University of North Carolina at Chapel Hill are analyzing existing septic regulations to see how they affect the use of non-conventional disposal systems. On the basis of the systems' maintenance needs, they will devise model management programs. In addition, Carlile and others with North Carolina State University's Soil Science Department are looking at the performance of alternative disposal systems. County government and health department officials are cooperating in each segment of the study.

As part of their preliminary work, the study team conducted an overview on septic tank problems and uses in the six-county region. The team identified the various alternative systems available, ranging from rejuvenated septic tank systems to non-conventional systems, and evaluated them on the basis of design, cost, operation and maintenance needs.

Demonstration systems were installed at different problem sites in each of the counties. To date, 25 modified systems have been installed in private homes and at small businesses. They include such techniques as the mound system, low pressure distribution system, recirculating sand filter, spray irrigation system and a conventional system using V-shaped ditches and cross-trenching.



*Carlile (top) and assistant Kent Messick inspect pump housing*

Currently work is being done to develop a three-acre demonstration facility adjacent to the municipal sewage treatment plant in Durham County. When completed the facility will enable researchers to compare the effectiveness of the various disposal systems under controlled conditions. Raw sewage will be taken from the treatment plant and placed in a series of septic tanks. Effluent from the tanks then will be run through the various systems and the levels of treatment compared.

Carlile is especially enthusiastic about the demonstration project. Not only will it serve as an educational facility for local contractors, engineers, health officials and interested property owners, but it will provide a valuable research center. "It will allow us to get some really hard and fast data for comparison of the alternative systems," says Carlile.

### State-wide efforts

On a state level, alternative on-site waste disposal has become a priority issue. Last year an ad hoc Alternative Sewage Disposal Task Force was created in an effort to bring together

information on waste disposal problems throughout the state. The task force is comprised of representatives from state and local government agencies, university researchers and concerned citizens.

Anne Taylor, special assistant with the state Department of Natural Resources and Community Development was instrumental in getting the organization started. According to Taylor the primary reason for the task force was to get resource people from across the state together and to find out 'who was doing what and where.'

"We realized that the state had tremendous capability in the area of septic waste disposal but it was spread throughout so many departments and universities," she said. "We were a leader in research but not in using what we had."

Up until now the role of the task force primarily has been advisory; reviewing waste treatment plans and setting up educational programs and workshops on alternative disposal systems. But a recent 208 grant from EPA should help the organization begin to formalize its work.

# THE BACK PAGE

"The Back Page" is an update on Sea Grant activities—on research, marine education and advisory services. It's also a good place to find out about upcoming meetings and workshops and new publications. For more information on any of the projects described, contact the Sea Grant office in Raleigh (919/737-2454).



To momick. It's not a verb you'll find in Webster's. But any Harkers Islander can give you its definition. In the "down east" dialect of Carteret County, it means to tear up or render useless. And here's another: ever heard of a paiser? On Harkers Island it's another word for porch.

Anthropologist Marcus Hepburn is intrigued by these little gems in the language of the residents of this relatively isolated island. He's been studying the linguistics, folklore and general way of life of the islanders since he moved to Harkers Island last spring. Hepburn is working with anthropologist Jim Sabella and sociologists Richard Dixon and Roger Lowery of the University of North Carolina at Wilmington (UNC-W). With Sea Grant funding, they're looking at Harkers Island as an example of a traditional boat building and fishing village. They hope that the information they collect will help planners and fisheries management officials to make decisions that are compatible with traditional lifestyles on the island.

Clams are an important fishery resource in North Carolina. When catches of other, more valuable shellfish are down, fishermen often turn to hard clams for supplemental earnings. But a combination of two extremely cold winters and an increase in clamming activity has fisheries biologists worried over the fate of North Carolina's hard clam population.

In an effort to learn more about the population dynamics and biology of the hard clam, Sea Grant researchers Charles Peterson and Richard Deriso of UNC's Institute of Marine Sciences in Morehead City are developing a clam sampling program in coordination with the state Division of Marine Fisheries (DMF). As part of the study the researchers will evaluate the reliability of using growth lines on the clam's shell for aging. The effects of mechanical harvesting on clam populations and the surrounding environment also will be examined.

In another study sponsored by Sea Grant, Deriso will assist the DMF in designing and implementing various sampling programs and techniques for fish stock assessment and population dynamics studies.



North Carolina is becoming a popular vacationland for SCUBA divers; the drawing card—the hundreds of shipwrecks strewn along the state's coast.

To help diving enthusiasts learn more about SCUBA diving off North Carolina, Sea Grant is sponsoring a free SCUBA conference on May 26 at the Marine Resources Center on Bogue Banks beginning at 9 a.m. Sea Grant agent Dennis Regan says the day-long conference will touch on a variety of topics. J. C. Jones of the Office of Marine Affairs will talk about World War II submarine wrecks and the controversy over torpedo disarmament. John Newton of the Monitor Foundation will present an update on efforts to recover the ironclad Monitor. Captain Ed Wolfe of Wrightsville Beach will discuss safety aspects of diving from charter boats. To help divers identify some of the fish they see, Steve Ross of the state Division of Marine Fisheries will talk about marine fish common to North Carolina waters. Bill Lovin, author of *Wreck*, will discuss underwater photography techniques. For

conference registration information, contact Regan at the Marine Resources Center/Roanoke Island (919/473-3937).



How effective are sand bag groins in erosion control? It's a question that's never been answered in North Carolina. But Sea Grant researcher Jerry

Machemehl of North Carolina State University (NCSU) thinks that a massive erosion control project along the west end of Long Beach, North Carolina, may provide an ideal testing ground.

Construction of the sand bag groin system was begun last month by the state's Office of Public Works in an effort to reduce shoreline movement in the vicinity of Lockwoods Folly Inlet. The area is experiencing severe shoreline erosion. With support from Sea Grant, Machemehl will look at both the long- and short-term effects of the groin system, how it responds to wave and current conditions and the benefit to cost ratio of the project. Sea Grant's coastal engineering specialist, Spencer Rogers, is assisting in the project. The results of the study could be important in determining whether the relatively low cost system can be successfully used in other locations.

Off-road vehicle (ORV) use has been stirring up quite a controversy along North Carolina's beaches. Sea Grant researchers Paul Hosier and Tom Eaton of UNC-W hope to find out what impact ORVs have on the beach environment. Preliminary results at a study site near Fort Fisher indicate that sand is churned up and vegetation is reduced where ORVs are used frequently.

This summer the researchers will expand their studies to include sites in the Cape Hatteras National Seashore. They've marked off test sites near Oregon Inlet, where ORV use is the heaviest in the park; near Cape Point

on Hatteras Island; and at another site on Hatteras Island. The researchers will compare differences in beach profile, sand transport and vegetation on ORV-impacted beaches and sites closed to traffic.



Sea Grant's new continuing education program for fishermen got off the ground last month with two evening classes on trouble shooting and preventive maintenance for outboard motors.

The class is the first of many to be sponsored under the new program. Continuing education coordinator, Wayne Wescott of Manteo, says future short courses will cover safety aboard ship, federal financial aid for fishermen, forming business associations and free U.S. captain's license training. For more information on the program, Wescott can be temporarily reached at the Marine Resources Center on Roanoke Island (919/473-3937).

In other education news, Sea Grant's Marine Education Materials System (MEMS) is coming to North Carolina. Sea Grant's marine education specialist Lundie Mauldin of NCSU has arranged for the microfiche collection of marine education documents to be housed in the Education Information Center of the North Carolina Department of Public Instruction.

A catalogue listing accession numbers for the microfiche is available

from UNC Sea Grant for \$5.00. Orders for the catalogue including checks payable to UNC Sea Grant, may be sent to Sea Grant, Box 5001, Raleigh, NC 27650. A complete set of the MEMS documents will be housed in the D.H. Hill Library on the NCSU campus.



Though we're only four months into 1979, the wheels already have been set into motion for next year's Sea Grant program. But before any projects are funded, they must undergo a series of reviews by both the UNC Sea Grant administrative staff and special committees comprised of university researchers and agency personnel from North Carolina and elsewhere.

To give you an idea of the various review steps that the projects must go through, we've included this year's schedule:

June 1—Individual project proposals due at the UNC Sea Grant offices in Raleigh;

June 4-30—Ad hoc, state agency and university review;

July 9-13—Proposals returned to researchers for revision;

July 31—Final project proposals due back to UNC Sea Grant office;

September 1—UNC Sea Grant program proposal due at the National Office of Sea Grant, Washington, D.C.;

September 25-27—Office of Sea Grant review and feedback;

January 1—Project funds awarded.

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## Lookout update

The days of the famous Cape Lookout Lighthouse are numbered. Citing the enormous expense of protective measures, the National Park Service (NPS) announced early this month that it does not intend to take steps to keep the lighthouse from washing into Barden Inlet.

The February issue of this newsletter described the plight of the lighthouse, which now stands less than 300 feet from the eroding shoreline of Core Banks. At that time several state and federal agencies were considering plans to save the lighthouse. Since it is currently developing the Cape Lookout National Seashore, the NPS was selected as the lead agency in the matter.

The light is still used as a navigation aid. So, if it is washed away, the Coast Guard plans to replace it with a simple metal tower at another location on Core Banks.

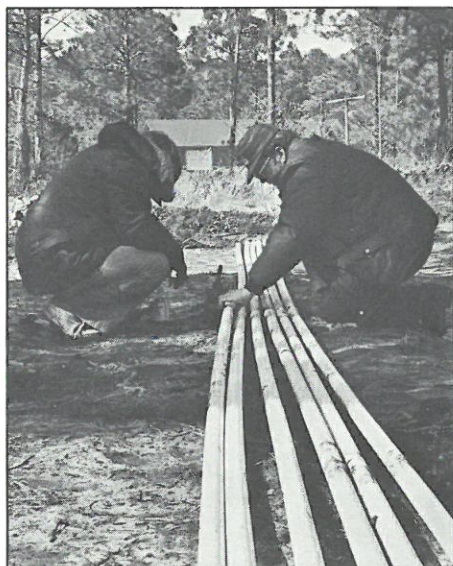
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*Coastwatch* is published monthly except July and December by the University of North Carolina Sea Grant College Program, 105 1911 Building, North Carolina State University, Raleigh, NC 27650, Vol. 6, No. 4, April, 1979. Dr. B.J. Copeland, director. Written and edited by Karen Jurgensen, Mary Day Mordecai and Virginia Worthington. Second-class postage paid at Raleigh, NC 27611.

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Coastwatch  
105 1911 Building  
North Carolina State University  
Raleigh, NC 27650

Second-class postage paid  
at Raleigh, NC 27611  
(ISSN 0161-8369)

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